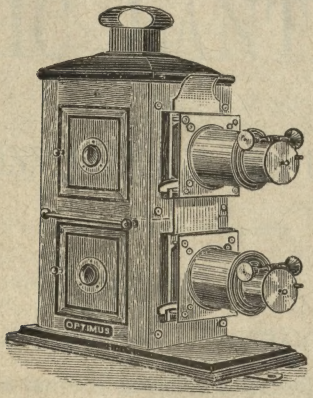
1st Edition.

THE

MAGIC LANTERN:



ITS

CONSTRUCTION AND USE.

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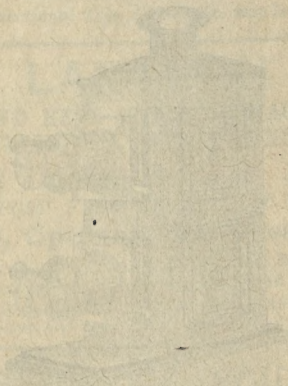


THE MAGIC LANTERN: ITS CONSTRUCTION AND USE.

CHAPTER I.

SINGLE LANTERNS WITH MINERAL OIL LAMPS.

THE magic lantern must be acknowledged as being the most popular of optical instruments. In the first place the wonderful effects produced by it, and which justify its name, are far out of proportion to the apparatus from which they spring; and in the second place, those effects are of such a nature, that they can be observed by a large number of persons at the same moment. The microscrope and the telescope can never become such popular favourites, for both those instruments, wonderful though they are, appeal but to the individual eye. Moreover, the eye must be educated before it can in any way realise the truths which the microscope and telescope are capable of demonstrating; indeed, it is not too much to say that a certain amount of education is necessary before the student can see anything at all with those instruments. But with the magic lantern all is different. A small picture, less than three inches across, is magnified by it to four, ten, fifteen, eighteen, and even twenty-four feet in diameter, the magnification being limited not by the size of the instrument,

or of the original picture, but by the power of the light available. This picture, brilliantly shown, can be understood by all. If it be a photograph—and photographs for this express purpose are now produced in endless variety, and illustrate nearly every country under the sun—its details are so brought out, that infinitesimal markings, which would not be otherwise suspected to exist, are made manifest and appreciable by every eye. We need say no more to demonstrate the popularity of the instrument, or to explain the reasons for that popularity.

Before describing the many different forms of magic lanterns which can now be bought, let us urge upon the would-be purchaser the advisability of choosing an English-made instrument. It would be out of place here to advise this upon patriotic grounds, although, no doubt, many good people would be influenced by such a right feeling. We urge it rather with regard to the purchaser's own interests; for it is a fact well-known in the trade, but which the general public are perhaps ignorant of, that the English market is flooded with inferior goods of foreign manufacture, which are so ill-made that they will hardly bear the wear and tear of mere transport, much less that of actual use. And the use of a magic lantern entails much more actual wear and tear than does the use of most optical instruments. It has to bear the strain of constant expansion and contraction—for the lamp within it is of a powerful nature—must be accompanied by considerable heat, and although in a well-made lantern this heat is carried off and diffused as much as possible, still there is enough left to act upon the material of which the lantern is made in the manner just indicated. In metal-bodied lanterns this heat expansion and subsequent contraction is a strain upon all the joints. If such joints be merely held together by imperfect soldering the result is easy to foretell. In wooden-bodied lanterns the heat will most surely cause the material to warp, unless it be well-seasoned. Should disaster occur to a lantern of foreign origin, the purchaser has little remedy. It can perhaps be patched up for a

time; "but," the buyer is told, "these things are made abroad, and English workmen do not understand them." A good English-made lantern is on the other hand a possession which will, humanly speaking, last for ever. And although an accident may happen to it, from careless usage, the injury can be quickly remedied, for there are those at hand who spend their lives in such work, and understand all its ramifications. These remarks do not apply so much to the toy lanterns of boyhood, as to the better class instruments which are designed for exhibition or educational purposes.

It is not our business to trace the history of the magic lantern, and it matters not one jot whether it was the offspring of Kircher, of seventeenth century fame, or of still earlier origin. Nor need we speculate whether it was used in some primitive form by priestly charlatans to delude visitors to their temples, with the idea that they were in direct communication with denizens of another sphere. Such speculations we must leave to the minds of those curious in such old-world researches. What we have to consider to-day is the present position of this most interesting and useful instrument, and to glean some notion as to the different forms in which it is presented to the public. With this object in view we will now enter into a detailed description of the different kinds of instruments which are displayed to the gaze of the purchaser, and will do our best to guide him in his choice. Albeit, this choice must first of all be governed by the purpose for which he requires the instrument. Let us suppose, to begin with, that the instrument is required to give as a present to some youngster, a supposition which will at once lead us to a consideration of the very simplest form of magic lanterns.

We may say, without much exaggeration, that such a gift to a boy in times not long since past, would be an act which would probably be resented by that boy's parents and immediate friends, for the reason that up to within quite recent times all the toy lanterns were fitted with very badly smelling and messy colza-oil lamps. Such a toy introduced into a household very

generally led to spoilt furniture, table-cloths, and carpets, which were hardly compensated for by the more legitimate effects produced by the instrument. The choice of a lantern as a present for a child was, therefore, not made very often. But now that many improvements have been introduced, not the least of which is the substitution of a safe form of lamp, burning the mineral oil, so familiar to all households, a different story may be told. There is not only an improvement in cleanliness and freedom from injury to carpets, etc., but a wonderful gain in light, as anyone must acknowledge who calls to mind the peculiar whiteness of a paraffin lamp, when compared with its prototype. So the boy's magic lantern has a new lease of popularity, and the improvements in its manufacture fully deserve that it should be thus favoured.

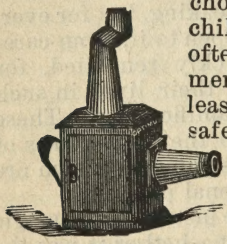


Fig. 1.

In spite of new arrangements and devices, the boy's lantern has not lost its simplicity of construction. It still consists of a metal body, with a lamp and reflector in it, a bent chimney above, and a tube in front to hold the lenses. These lenses cannot of course be compared with those fitted to lanterns of more pretension, and at a higher price, but they are the best of their kind obtainable for the sum at which they are sold. The entire apparatus forms a great contrast to that which our forefathers had to be content with; for improvements in methods of manufacture, the introduction of machinery, and the thousand and one advantages under which the modern workman labours, has affected magic lantern construction as it has affected nearly every other branch of human enterprise. But the greatest improvement, as already indicated, is found in the source of light—the mineral oil lamp. In such a lamp we must employ a chimney or chamber, in order to make the combustion complete. In the more

Fig. 2.

expensive lanterns this condition is fulfilled by a large lamp of special design shut into a combustion chamber. In the smaller lanterns designed for boy's use this would be impossible, and a glass chimney takes its place. The oil receptacle is sunk below the level of the base of the lantern, so that it cannot by any possibility become over-heated, and so represent a source of danger, while the heated air and products of combustion are carried into the iron chimney of the lantern. Such a lamp requires but little attention, beyond careful trimming of the wick and general cleanliness. If a lamp smells in use, in nine cases out of ten the fault is due to paraffin smeared upon its outside, to faulty trimming of the wicks, or to incomplete combustion. This last happens both when the wick is too high or when it is too low. In the first case the lamp smokes, and in the last an invisible but unpleasant vapour is given off.

The size of the slide or picture, which can be used with any given lantern, is regulated by the size of its condensing lens, that is to say, the lens which is nearest to the light. For all lanterns, be they toy or the most perfect instruments which it is possible to conceive, have two complete lenses, or sets of lenses, which comprise what is known as the optical system. The condenser is so named because of its duty; and its sole duty is to concentrate or *condense* the light upon the small transparent picture or lantern slide. The front lens has to enlarge the image of the picture thus illuminated. In the boyish lanterns under present consideration, the size of the condensing lens is from one and a half inches in diameter to $3\frac{1}{2}$ inches. So that the user of such a lantern is confined to the employment of pictures of the size of his condensing lens, or more correctly, rather under that size. Such pictures are supplied with the lantern, or can be purchased separately. But many young folks nowadays know something about photography, and it is not at all difficult to make photographic pictures which will show well in these lanterns. We shall have a good deal to say regarding the production of such pictures in a subsequent chapter.

If we employ a lantern with a $3\frac{1}{2}$-inch condenser, we have at our disposal something which is more than a mere toy, for with it we can exhibit pictures of what is known as the normal size, namely $3\frac{1}{4}$ by $3\frac{1}{4}$ inches. This size has now been adopted by all manufacturers of lantern slides, with few exceptions, and where an exception is found it affects the breadth and not the height of the picture In one sense, indeed, it does not affect the picture at all, but merely the size of its margin. When purchasers are aware of this they will be tempted to buy a lantern capable of accommodating the normal size of picture rather than a slightly cheaper one which will take only those of a smaller size.

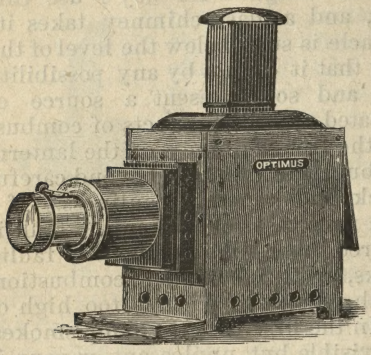


Fig. 3.

From the larger kind of boy's lantern, then, we spring at one jump to a lantern which can be used in the small lecture-room or schoolroom. We say small room, because, let it be remembered, that we are still considering lanterns which burn mineral oil; and although this form of lamp gives abundant light for a small room, it would be expecting too much of it were we to depute it to do exhibition work in a large hall. For such an instrument we must employ the more brilliant lime-light, to be discussed later on.

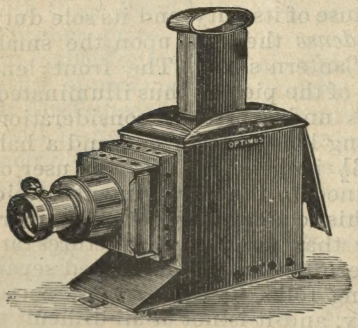


Fig. 4.

The cheapest form of oil lantern next above those which belong to toy-land, represents a great step in advance, not only in the form of lamp employed, but also in the optical system with which it is furnished. Let us deal with the lamp first. It is made of iron, and is carefully constructed, with a view to utilise all the light obtainable from wicks fed by mineral oil. It has three broad-plaited wicks, set longitudinally with regard to the lantern, and these wicks burn with great steadiness and regularity in a combustion chamber. The end of this chamber is furnished with a thin glass screen, which is brought against and almost touching the condensing lens. A tall chimney, also of iron, provides the necessary draught for this powerful form of lamp.

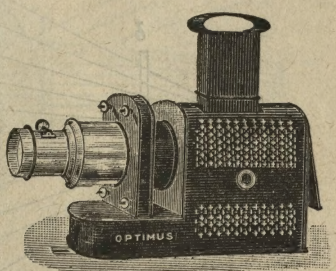


Fig. 5.

With regard to the optical system of this improved lantern, we must notice at once that in one very important respect it differs from the boy's lantern already described. The lenses are no longer single glasses, but are compound. The condenser, four inches in diameter, instead of being a "bull's-eye," like that fitted to a policeman's lantern, consists of two carefully-ground plano convex lenses, set in a cell, so that their curved surfaces are presented towards one another, and are nearly in contact. This employment of two lenses, in lieu of one, corrects certain optical faults, which are inseparable from a single lens. In like manner the objective, or front lens, presents a great improvement on the mere single form. Here, instead of a single piece of glass, we have a combination of carefully ground lenses, which secure good definition and ample carriage of light from the condenser, and great efficiency in every way. And here again we must remind the reader

that these lenses are carefully made, and give crisp definition. (See Fig. 7a.)

The important part which the condenser plays in the optical arrangement of the magic lantern is clearly shown by the diagrams Fig. 6 and Fig. 7. In the first one A is the luminant and B the lantern picture, the projecting lens being indicated at C. Now it will be noticed that the fan-like bundle of rays coming from the luminant strikes through the transparent picture (B) in such diverging directions that only those few which are horizontal can find their way through the objective lens. Of course this is only a diagram, but if we were to reduce the matter to practice and were to attempt to throw a picture with the objective lens only, we should find that the central portion of that picture only would be apparent on the screen.

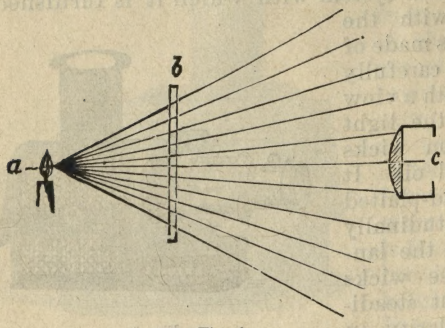


Fig. 6.

In Fig. 7 we have the same general arrangement of parts, only with the condensing lens (D) inserted; and it will be at once seen what a very important change in the conditions under which the picture is shown has been thus effected. We now see the meaning of the term "condenser," for the rays which were formerly spread out and wasted—their direction is here indicated by the dotted lines—are now *condensed* and bent forward in such a manner that the whole bundle of them is driven through the objective lens.

We also give a diagram of the Petzval form of lens, or portrait combination, which is found to be, with certain modifications with regard to aperture, the best form to employ for the lantern. It is curious to note that this was the first description of lens ever made for photographic

purposes. (See Fig. 7a.) It supplanted the telescope objective to which early experimenters were confined in their photographic work. Although various other forms of lenses have been invented since, and are far more useful for particular classes of work, the Petzval still holds its own as being unsurpassed for giving a flat field and plenty of light for lantern work.

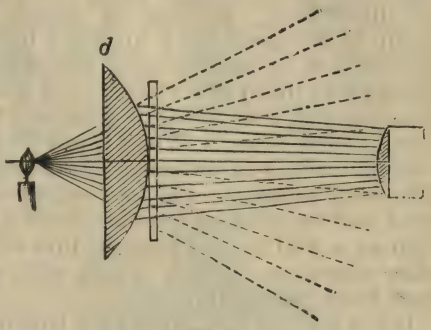


Fig. 7.

It will be convenient to pause here in our description of these various lanterns, to point out that the instrument has a far higher mission than mere amusement. Of late years, and more especially since it became possible to use photographs instead of hand-painted pictures in the lantern, at a fraction of the expense necessary when artists were employed in this work, the instrument has been recognised as a valuable aid to education. In the better class of schools it is commonly employed, and there is every reason to believe that its use in education will become far more general as time goes on. There is hardly a single branch of knowledge in which it cannot be usefully introduced as a demonstrator. Slides, illustrative of chemistry, electricity and magnetism, physiology, and all the other ologies, are now to be had in wonderfully complete sets. These various sets can be kept at hand by the teacher; a lantern can be lighted up at a minute's notice. A sheet rolled up like a blind when out of use

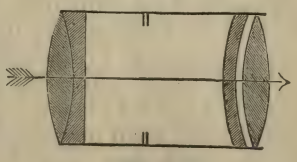


Fig. 7a.

can be pulled into position, and in a few minutes all is ready for a lesson, in which the pupils will take far more interest than they could in one not so illustrated. It may be urged that a darkened room is not conducive to order if the pupils are at all inclined to inattention. But a really good master has no trouble in this respect, and if he had, it must be remembered, that absolute darkness is not a *sine qua non* in such work. Where a public exhibition of lantern pictures is in progress, darkness is one of the conditions of success. But in a schoolroom, where effect need not be studied, the details of a slide can be well seen on a wall that is brought into shadow by a moveable screen or curtain, which will guard it from the light from the window.

It is a curious fact, but a very true one, that a subject which is dry and unpalatable of itself, can be rendered very attractive if it be illustrated by the lantern. Take for instance such a theme as physical geography. By itself, unless the teacher be gifted with unusual eloquence and talent, it will lack attraction to young people. It is next to impossible to convey to their minds by mere description the variety of natural wonders which are embraced in this new object of study. But how lavishly can it be illustrated by means of lantern photographs! Instead of being confined to mere maps—always most uninteresting things to pupils—they can have views in abundance of the countries under consideration, which will rivet their attention, and make them remember what they have been taught. Such views, intelligently interspersed among the necessary diagrams and drier matter, will help the teacher as much as those whose minds he is training, and will make the work a pleasant one to all engaged. Natural phenomena, from a lightning flash to the gentle ripple on the sand, can now be illustrated by means of photographic pictures, in a manner which only a few years back would have been considered impossible.

But the educational value of a lantern does not begin and end with mere pictures and diagrams, for a great many actual experiments can be made evident to a large

class by its use in the hands of an intelligent master. By employing a lantern which has what is known as an open stage, instead of one merely open at the sides for the reception of the ordinary slides, the capabilities of the instrument are greatly increased. Such a lantern is that shown in Fig. 36. Upon this lantern stage can be placed the usual pictures, or small apparatus for experiments, the image of which is projected upon the screen. Detailed description of some of the apparatus which can be thus employed is reserved for a subsequent chapter.

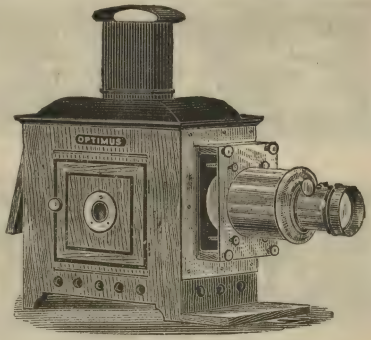


Fig. 8.

Another step in advance in lantern construction is indicated by the employment, or rather the addition of a polished mahogany body to the instrument, as seen in Fig. 8. Here the essential features of the lantern remain as before, but the casing is added, and gives the apparatus a handsome appearance. The metal now forms an inner lining, but there is an air space between it and the wooden case, which prevents undue heating. At the same time, the stage, the sliding tube holding the lens mount, and other metal parts are of black japanned iron.

The addition of brass work to the lantern last described greatly improves its appearance, and its ease of working, for the highest skill cannot make an iron tube slide into one of the same metal as easily as with tubes of brass, one reason for this being that the brass tubes are turned in the lathe, and the iron ones cannot be so treated. The brass tubing may, moreover, be furnished with two or more draws, after the fashion of a telescope. And let it not be thought that this is a mere ornamental appen-

dage, for in reality it represents both a convenience and a distinct optical gain. It becomes advisable sometimes to use a lens of longer focal length than that generally employed. For instance, the normal lens will probably afford a six-foot disc at a distance of ten feet from the sheet. But suppose that the lantern is required for occasional use in a room which has a length of 20 feet, and that for many reasons it is best to carry the lantern quite to the back of that room.

Figs. 9, 10, 11

Under such circumstances it will only be possible to get a disc of the old size by using a longer focus lens, and such a lens must be placed at a correspondingly greater distance from the condenser. It is here that the telescopic draw tube comes into use, and no lantern fit for public exhibition purposes is complete without such an accommodation. It can certainly be dispensed with for mere educational work, but, as we have seen, there is a distinct gain in its employment.

In toy lanterns (Figs. 9, 10, 11) the pictures are on

sliders, that is to say, a certain number of pictures are painted on one slip of glass, and this is *slid* through the lantern stage, so that the pictures appear panorama fashion, one after the other. This arrangement would be cumbersome when we come to deal with pictures of the standard ($3\frac{1}{4}$ by $3\frac{1}{4}$) size, besides which the production of photographs in that form would be costly, if not often impossible. As these pictures are supplied by the manufacturer, they consist of a photograph on glass, protected by a plain glass of the same size, the two being bound together by an edging of paper, but separated in reality by a frame or mask. Before we can show such pictures in the lantern we must employ a carrier to hold each while it is being exhibited. This

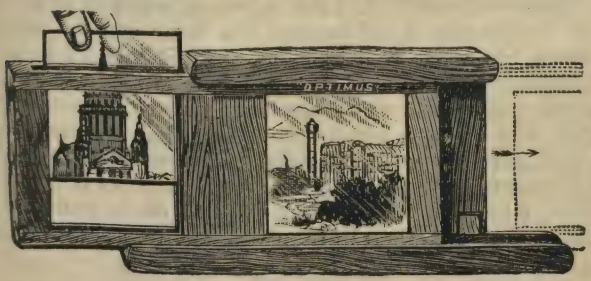


Fig. 12.

carrier is of wood, and fits tightly into the stage of the lantern, and there is no better form made than that shown at Fig. 12.

This carrier consists of a frame of wood, in which slides to and fro a smaller double frame, each half of which will accommodate a picture, either of which pictures can be brought into position in front of the condenser. The first picture having been shown, the inner frame is pushed forward, so that the second picture takes its place. The first picture is now outside the lantern, and can be removed and replaced by the third in order. In due time this is shifted into position, when No. 2, already shown, is taken out, and No. 4 takes its place, and so on to the end of the series. By

this arrangement the sheet or screen is never left blank, nor is there any tiresome pause whilst the pictures are being changed. There are many carriers made, but this is after all one of the simplest and best.

Fig. 13.

Before closing our account of the more simple forms of magic lanterns, we may usefully call attention to a convenient contrivance which has been recently introduced as a help to trimming the wick or wicks of the mineral oil lamp. It is most essential in these instruments that the wick should be cut perfectly square and straight, and should be free from any ragged edges. It is next to impossible to secure these desiderata with ordinary scissors; and the operator who tries to do so has frequently to blow out his lamp and try again before his wick will burn as it should do. All this difficulty is obviated by using a proper wick-clip, which has been devised for lantern use. It covers the wick, and a single action cuts a fresh and even surface, which is ready at once for duty. No one who has used this instrument will ever care to be without it, for the wick when saturated with mineral oil is extremely tough and repellant of any other form of cutting instrument. See Fig. 13.

Enlarging (Lantern) Apparatus.

Closely allied with the magic lantern is the apparatus for enlarging photographs,—and naturally so, for the lantern offers at once a means of throwing an enlarged image of a picture placed within the influence of its optical system. But as we have seen, the pictures available for lantern use are, on account of many considerations, limited to a certain size, this size being fixed, by general consent, at $3\frac{1}{4}$ inches square. But this area is reduced by the margin of the picture, and by the system adopted in mounting it, to something less, so that we may regard the largest sized picture available for the lantern to be about $2\frac{3}{4}$ inches in diameter. If, therefore, we intend to use the ordinary lantern for enlarging purposes—and it can be so used,—the negatives

employed in the operation must not be be much bigger than the size just given, or the condensing lens will not be large enough to cover them with the needful flood of light. But the smallest negative commonly known to photographers is one known as "quarter plate," and which measures $3\frac{1}{4} \times 4\frac{1}{4}$ inches. To enlarge such a negative a condenser measuring at least 5 inches in diameter is necessary, and for larger sized negatives the condenser must be of a corresponding size.

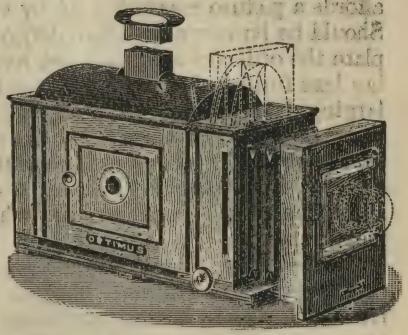


Fig. 14.

In Figs. 14 and 15 we show two forms of enlarging lanterns which have been the result of much careful study, and of a full knowledge of what is required by the photographer be he professional or amateur. The apparatus comprises a condensing lens of a size larger than the negatives for which it is intended, a powerful 3-wick mineral oil-lamp—which can be replaced by a lime-light jet if required—and a portrait lens which is well suited to the work, and which, moreover, can be unscrewed and used with a camera for obtaining a portrait negative when required.

For general use the lanternist who combines photography with his work, as all efficient lanternists certainly should, a

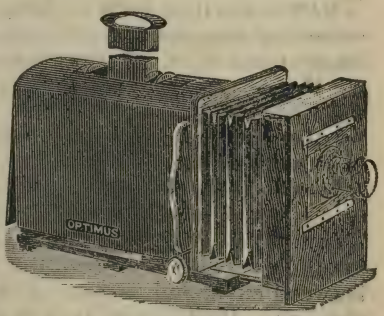


Fig. 15.

$3\frac{1}{4}$ by $3\frac{1}{4}$ camera will be found more useful, perhaps, than any other size, although a quarter-plate camera which affords a picture measuring $3\frac{1}{4}$ by $4\frac{1}{4}$ is equally serviceable. Should he however wish to enlarge the whole of a quarter-plate the ordinary lantern is not available, for the condensing lens furnished with it will not cover it. Here, the enlarging lantern is the proper instrument to use, its size being governed by the size of the negative to be enlarged. To ascertain the proper size, measure the negative diagonally, *i.e.*, from corner to corner, and choose an enlarging apparatus, the condenser of which agrees with that measurement.

This enlarging apparatus has a very wide field of work. It can be used for obtaining enlarged negatives on dry plates from such positives, or for producing direct enlargements on bromide paper from small negatives. For those who are engaged in other work during the hours of daylight—as is the case with most amateurs—this enlarging lantern offers a great attraction, for it is essentially an instrument for employment at night. It is handsome in appearance, is strongly made, and packs away into a box when not in use.

CHAPTER II.

The Lime Light. Oxygen Making.

WHAT is the lime light? Many will regard this as a somewhat unnecessary question, on the ground that they know what it is. But there are many more who have not that advantage, and for their benefit we will answer the question propounded. It is certain that a large number of people do not know the difference between a lime and an electric light. They are both unusually bright, they think; and with that happy indifference to things which do not immediately concern them—which is common to most of us—they enquire no further. And yet the distinction between the two is as great as that between chalk and cheese. The electric light is expensive, the lime light is not so. The electric light

requires a complex battery, or a machine worked by a steam engine ; while the lime light is easily produced by a simple apparatus and materials. Were it not so, it surely would not be so extensively used as it is for lantern work all over the world.

When first discovered by Lieut. Drummond, and called therefore for many years after his name, "The Drummond Light," great hopes were entertained that it would come into common use for various purposes. Many persons will remember how it was tried for general lighting—about 30 years ago—on old Westminster Bridge. For reasons which will be seen later on, their anticipations were doomed to disappointment, and the lime light is now used—if we except its employment at theatres for scenic display—almost exclusively for the magic lantern. But again—what is the lime light?

It is so called because it depends upon a ball or cylinder of lime—which is rendered white hot by the action of the two gases, hydrogen and oxygen. The first of these gases—in a compound form well adapted for lantern use—is at hand, for it is the gas which we most of us burn in our houses. An indiarubber tube from the nearest gas bracket or chandelier will supply our lantern without any trouble ; but it is of no use for our present purpose unless allied with its brother—oxygen. Oxygen is one of the commonest things in nature, but, unfortunately for lantern workers, it is always associated with something else, from which it must be separated before it is available for the lime light. Of the air we breathe, about one-fifth is oxygen. Of the water we drink a large part is composed of oxygen. Iron rust is composed of oxygen combined with iron, *i.e.*, oxide of iron—obtained either from air or water. Similar examples might be multiplied to prove the very general occurrence of oxygen in a combined state in and around the earth upon which we live. In order to procure it of the necessary purity for lantern work—and absolute purity is not essential—we must look for some substance from which it can be separated with ease and cheapness. Oxide of manganese was at one time almost universally employed

for the purpose; but now chlorate of potash—owing to its cheap production—has usurped its place.

Chlorate of potash is a compound which, like all other chemical substances, possesses a definite composition from which there is no deviation. It consists of chlorine 35·5 parts; potassium, 39·1 parts; and oxygen, 48 parts—all by weight. On the application of heat, the whole of this oxygen is given off, and can be collected for use in a bag or gas holder. It is obvious that we can get a definite amount of gas from a given weight of the salt. The residue which remains behind after the gas has been so extracted, is called chloride of potash—which is quite useless so far as lantern work is concerned.

If this chlorate of potash is heated by itself, the chemical action aroused is so violent that it is almost impossible to control the out-flow of gas. It is therefore customary to dilute the salt, as it were, with some inert substance, which will render it more tractable. This may be oxide of iron, sand, or oxide of manganese. The addition to the mixture of a certain quantity of common salt, also has a restraining effect upon it. If sand be used it must first of all be sifted, in order to eliminate any particles of weed or other carbonaceous matter, which forms, with the chlorate, an explosive mixture. The chlorate itself should invariably be carefully picked over by hand for similar impurities—in this case represented usually by fragments of paper, chips of wood and straw. On the whole, we may say that manganese is the best material with which to make the oxygen mixture—and we confidently recommend the following formula:—

Fig. 16.

Chlorate of potash	... 2 lbs.
Manganese ...	... ½ ,,
Common salt ...	... ½ ,,

These ingredients should be carefully mingled together shortly before the gas is required. The potash should be in crystals, not powdered,

but if any of these crystals are of unusually large size, they are best broken up. The manganese should also be in fine powder. Some operators recommend the lump variety for oxygen making ; but we have found that it necessitates a much greater degree of heat, and that in many other ways it is inconvenient.

The black mixture thus formed is put into a retort, (See Fig. 16) the quantity quoted being enough to fill a bag of about nine feet capacity. This retort should be made of sheet iron with a stout convex bottom, and the best source of heat is a gas stove. These stoves are now sold of an annular form, and one should be chosen which agrees in size with the base of the retort. At the top of the retort there is a branch or pipe, which carries off the gas as fast as it is generated, and this pipe is connected by indiarubber tubing, first to the wash-bottle, and subsequently from that bottle to the bag which has to be filled with the gas.

A small amount of heat is enough to start with. The retort is placed on the lighted stove, and it is joined by tubing to the wash-bottle. The gas bag may for the present remain disconnected. And now a word about this wash-bottle or purifier (See Fig. 17.) It consists of a tin vessel which is half filled with water, and to which are attached two pipes.

Fig. 17.

One of these proceeds through the lid, and reaches almost to the bottom of the vessel inside. This pipe is in direct connection with the retort, so that when the gas comes it bubbles through the water, and is freed from any particles of solid matter which might come away with it. The other pipe springs from the top of the purifier, and leads the washed gas away to the storing bag.

When the connections have been made, and the stove lighted, the gas will soon be heard bubbling through the water of the purifier. But as yet it is mingled with the air in the retort, so that no attention need be paid to it. Let it run to waste for a minute or so. Now test

the gas which issues from the delivery tube of the purifier, by holding against it the smouldering end of a blown-out match. If the match burst into flame we may be quite sure that the gas is coming off purely enough for use, and we can immediately connect the bag with the tube from the purifier, and leave it to expand as it fills with gas. Let it be observed here that although oxygen is the great supporter of combustion, it will not light of itself. It will cause, as we have seen, the red spark on a match to burst into flame, but of itself it is actually uninflammable.

It will often be noticed that the oxygen smells strongly with a suffocating odour, which makes the operator cough in the most uncomfortable manner. This is due to free chlorine from the potash salt, and cannot be avoided. It unfortunately has a corrosive action upon the bag, its fittings, and the metal parts of the lantern, so that it is as well to neutralise it as much as possible. A piece of caustic soda in the wash-bottle will absorb most of it; failing this, a broken lime cylinder will do as well, the lime taking hold of the chlorine and changing it to chloride of lime. If the gas be kept for some hours in the bag before use, the chlorine gets absorbed in the material of the bag, and oxygen is supplied to the lantern in a very pure state. But this is clearly to the injury of the bag, and we may also say to the deterioration of the gas. For although a thick gas bag is supposed to be gas-tight and inpenetrable, as a matter of fact, all such bags are porous. By the action known to chemists as *endosmose* the gas within the bag slowly gets through the porous indiarubber, a like quantity of external air taking its place. If, therefore, a bag apparently full of gas be kept for some weeks, it will be found at the end of that time to contain air rather than oxygen. In theatres and large establishments where large amounts of oxygen are used, it is customary to store the gas in metal holders. These are after the pattern of the huge erections seen at gas works, that is to say, an inverted cylinder is sunk into a well of water. As the gas is supplied to it the cylinder rises, and is helped

in its movement by the action of counterweights. But such contrivances are only necessary where oxygen is consumed on a very liberal scale.

We see then that the apparatus for making oxygen gas is of a very simple character—so simple indeed, that professional lecturers think nothing of carrying the necessaries with them, and making gas a short time before the lantern has to be used in public. A retort, gas mixture, a gas stove, tubing, and purifier, are all that is required. Add to these things a little care and intelligence, and gas making will not be found difficult.

A retort will last a long time if it is not subjected to an unfair amount of heat. After use it should be unscrewed from its branch and thoroughly washed with many changes of hot water. If this be not done, the residue from the gas mixture will form a rock-like mass at the bottom of the vessel, which it is almost impossible to dislodge. Moreover, this collected mass has a destructive effect upon the metal. If, therefore, you want a retort to do good service before it is worn out by fair wear and tear, wash it well directly after use, and dry it by heat.

Of late years, oxygen gas has become a marketable commodity, and its sale has been much increased by the discovery that it can be cheaply separated from the atmosphere. The process requires extensive plant, and is quite beyond the power of the amateur worker ; still it possesses much interest. To understand the method it must first of all be remembered that the air around us is composed of oxygen one part, to four parts of nitrogen. This nitrogen is an inert gas, which seems to merely dilute the oxygen and render it fit for breathing. If we breathe pure oxygen, it would be far too strong for us—that is to say, the various vital processes would go on at such headlong speed that we should soon die, worn out before our time. Now to procure pure oxygen from the atmosphere we must separate it from the nitrogen with which it is associated. A salt called oxide of barium has the property of absorbing oxygen from the atmosphere if it be heated to a certain temperature, and—curiously enough—if

the heat be afterwards increased, it gives up the gas thus absorbed. This, then, is the secret of the new process for procuring oxygen. Large quantities of oxide of barium are heated in special retorts, and when this barium has taken up all the oxygen which it can, the heat is increased, and it parts with the gas. This is collected and compressed into steel cylinders, in which form it is sent out to customers. Those then who do not care for the trouble of making gas for themselves can buy it ready made. With a bag or bottle—as these steel cylinders are called—full of oxygen—and with access to a supply of house gas, the lantern operator has at hand the elementary constituents of the lime light. A description of the various kinds of lime burners—as used in magic lanterns—we must reserve for a fresh chapter.

CHAPTER III.

Lime Light Jets.

We have already explained that the lime light is produced by the heat from the combined gases, oxygen and hydrogen, impinging by means of a blow-pipe upon a cylinder of lime. It stands to reason that this condition cannot be fulfilled without the employment of some special form of jet, which shall not only hold the lime cylinder in a proper position, central with the lenses of the lantern, but shall also provide a means for carrying the two gases in question to the point of combustion. A simple form of jet may be described as follows:—It consists of a pin, which holds the lime cylinder, this being bored throughout its length with a hole, so that it will fit over that pin; and in front of this, that is, next to the condensing lens, there are two tubes, one for the hydrogen gas and one for the oxygen. The hydrogen jet is vertical, while the oxygen pipe is bent over, so that the gas which it emits rushes through the hydrogen flame and impinges upon the lime cylinder behind. This jet has the merit of being

most easily managed, even by the most inexperienced, and it is one, therefore, which is especially suitable to the novice in lime light matters, who might perhaps have some slight difficulty if he employed a form of jet of greater pretensions. The light given by this simple form of jet, while exceedingly bright and far more brilliant than any kind of mineral oil lamp, is not so good as the light produced by the next pattern to which we call the reader's attention.

In Fig. 18 we have the same principle exhibited, that is, what is known as the blow-through system; but the jet is of better construction, and there is a slight alteration in the manner in which the gases are delivered to the lime, which at once increases its efficiency as a light producer. At the same time it is not quite so

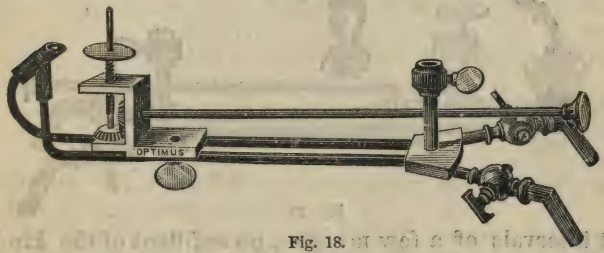


Fig. 18.

easy to work as the form of jet just described. The principal alteration is seen at the very tip of the jet, that is, where the gases meet the lime. In this form of jet it will be observed that the two nozzles are not separate, but combined, the oxygen nozzle lying within the tube which furnishes the hydrogen. By this arrangement the gases become better mixed than they do in the former arrangement. and the light is proportionately increased. As already indicated this form of jet requires a little more care in working, and for the following reason:—When the gases first come into contact they form an explosive mixture, and although there is no danger in the slight crack which is heard, if the oxygen is turned too suddenly into the hydrogen, still the explosion is sufficient to blow out the flame from the jet. Care, therefore, must be taken to turn

on the oxygen tap, very gradually, when this inconvenience will not occur.

In all lime light jets provision must be made for so turning the lime cylinder that a fresh surface is exposed from time to time to the action of the blow-pipe flame, for the intense heat of this flame, which is that of an oxy-hydrogen blow-pipe, be it remembered, causes the lime to pit at the point attacked by the gases if the lime cylinder is allowed to remain still for any considerable time. This pitting not only endangers the lime cylinder itself, but it may cause a flame to be reflected upon the condenser of the lantern, and fracture it; but if the lime cylinder be kept turned

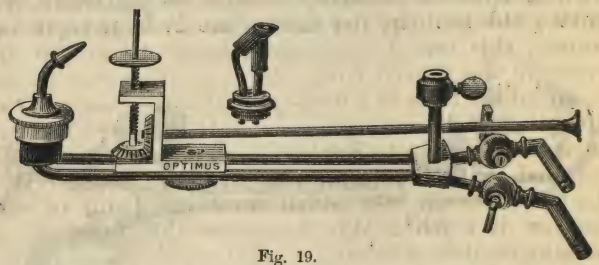


Fig. 19.

at intervals of a few minutes, no accident of the kind can happen. This turning motion is brought about by setting the lime pin upon a screw, which is worked from the exterior of the lantern, through the medium of bevelled wheels. The action is better shown in the jet shown at Fig. 19. There is another lime-turning arrangement, which is far more simple in appearance, but not quite so good in practice. The bevelled wheels are superseded by a spiral spring, which can be turned from the outside of the lantern, and which revolves the lime cylinder as required. Once more directing attention to Fig. 19, we may notice that the jet is of somewhat peculiar construction: the two pipes for the gas supply to the lime fitting into a kind of circular box. This jet may be described as an interchangeable one, that is to say, the two pipes referred to can be bodily removed and replaced by a single blow-

pipe, thus forming what is called a mixed jet. This we shall refer to at greater length presently.

The forms of lime light jets already described, although of somewhat different patterns, may be grouped under the head of the safety or blow-through system. We have mentioned why this term blow-through is adopted, and we may now explain why this jet is supposed to combine in itself the attribute of safeness. Hydrogen and oxygen gas when mixed together, form an explosive compound, and if this were not the case, the simplest plan would be to mix the two gases together in certain proportions in one bag, and to use that bag as the gas supply for a simple blow-pipe. But such a mode of working would be dangerous, for unlike the ordinary gas which we are used to in our houses, this mixed compound would be apt, if the pressure was moved from the containing bag, to run down in the form of a flame into that bag, and explode the mixture therein contained. It therefore becomes necessary to use a jet having the arrangements already detailed, with the result that in the forms described, the gases cannot mix at all until the point of combustion is reached; this fact gives this form of apparatus its title of safety.

In careful hands any form of jet, provided it is properly constructed, may be described as safe; and this word therefore may be looked upon as more of a trade-term, to distinguish a certain class of jet, than as one which confers the title of safety upon the apparatus to which it is attached. But when all is said and done, and taking everything into consideration, there is no doubt that this safety jet, as it is called, is far the best for amateur use. It is not only easy to work, but it requires only one bag of gas, namely, the oxygen, the hydrogen being supplied from the nearest gas bracket in the house in which the lantern may be used. It will thus be seen that it not only presents many advantages, but it is less expensive in employing one gas receptacle instead of two.

We have now to consider another form of jet; the one which is most commonly used by public lecturers

and exhibitors. It gives the best possible amount of light, and in this respect is much in advance of the blow-through system. While the blow-through jet will satisfactorily provide sufficient light for a sheet of 10 or 12 feet in diameter; the mixed jet can be used for far larger screens, and has covered, on certain occasions, sheets measuring 30 feet across. As its name implies, the gases are mixed, but not in the way that the reader may at first imagine. The ordinary household gas supply is no longer available for furnishing direct the necessary hydrogen, for both gases must be kept under the same pressure, either in bags or steel cylinders. It will simplify matters for the present if we confine our attention to the mixed jet supplied from india-rubber gas bags; such a jet is shown at Fig. 20. It

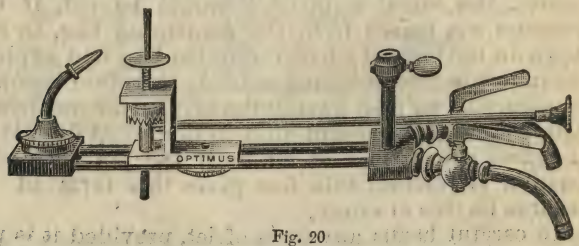


Fig. 20

will be seen at once that it differs mainly from the blow-through jet in having one single delivery pipe opposite to the lime. It has two taps for the conveyance of the gases, which, however, remain perfectly separate until they meet in the chamber immediately below this delivery tube or nozzle. So it will be seen that although the apparatus is called the mixed jet, the gases really do not come together until they are within about an inch-and-a-half of the point of combustion. But this mixture is quite sufficient to make a notable difference in the amount of light given; while at the same time the extent of surface on the lime cylinder which is rendered incandescent, is smaller than the surface heated by the blow-through jet. This is a distinct gain, for the more nearly the source of illumination approaches a *point* of light in size, the better is the definition afforded by the lenses.

Gas Bags.

Gas bags are made of stout indiarubber, covered with twill, and lined with canvas, and if well made, are so strong that they will bear a pressure of about two hundredweight. They are constructed in the form of a wedge, so that they can be placed between a single pair of pressure-boards hinged at one end. The bag fits between these boards, while the stop-cock at the thin end of the wedge protrudes through an opening cut in those boards for its accommodation. On the upper part of the top board there is a ledge against which the necessary weights are placed. In using the blow-through jet, it is customary to commence work when the bag is full, with one 56 pound weight ; but after about an hour's work, when gas bag is half empty, the pressure sinks, and the operator places another weight by the side of the first, if he wishes to maintain a good light. A simple pair of boards is sufficient, as we have before indicated, for a blow-through jet ; but if the mixed jet is in use, we require two bags, one for each gas. And in order to avoid any accidental mixture of these gases, by filling up a bag which is half empty with the wrong gas, it is as well to mark one bag with a large H, and the other with the letter O. It used to be the practice to place these bags under separate pressure boards, each with its supply of weights; but it is now customary to use a double pressure board so made that the two bags are contained one above the other; a single set of weights furnishing the pressure for both. (See Fig. 21.' This is a great improvement on the older plan, for it saves space, and also

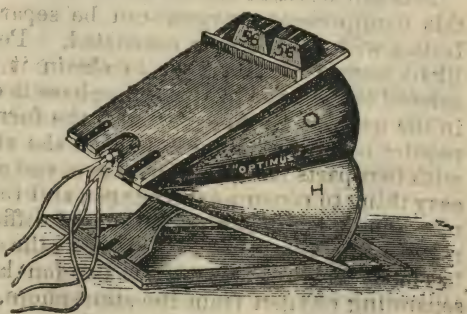


Fig. 21.

saves the necessity of having a double set of weights. We may sum up this question of lime light jets by saying that the form first considered is most suitable for the novice; the second form or blow-through jet is most serviceable to the amateur or experimentalist; and the last named, the mixed jet, for public exhibitions.

CHAPTER IV.

OXYGEN GAS IN CYLINDERS.

OXYGEN, upon which the lime light depends for its brilliancy, is one of the most common elements found in nature, but, as we have already pointed out, it does not occur in the form in which we require it In other words, it is always found combined with something else. Thus it is found in nearly all the rocks and earths of the globe. It forms one-fifth part of the air which we breathe, and in every nine pounds of water there are eight pounds of oxygen.

It is the work of the chemist then, to find out how this omnipresent oxygen can be separated from the bodies with which it is associated. Perhaps the most likely source from which to obtain it might be considered the air, for in the atmosphere it of course exists in the gaseous form, and that is the form in which we require it for the lime light. In the air it is mingled with four parts its bulk of nitrogen, and although it is an easy thing to consume the oxygen and thus separate the nitrogen, it is a very complex and difficult process to reverse this operation, and preserve the oxygen. There has lately been established in London large works for separating oxygen from the atmosphere, and the gas is now supplied to lime light workers and others, compressed in steel cylinders. About gas supplied in this form we shall have more to say presently. The earnest worker, in whatever branch of labour he may be engaged, likes to be self-dependent as far as possible, and even should it be inconvenient to the lanternist

always to make his own oxygen gas, he should certainly be in a position to do so should occasion require it. It will be a comfort to him to think that he has not to depend upon others for this first requisite of his work. Another satisfaction will be experienced by him in knowing that the gas is what it ought to be. It has been made under his own superintendence, and has not been mixed or diluted or in any way rendered of doubtful quality. If he trusts others to make gas for him, he is of course apt to suffer from their carelessness or mistakes. The gas supplied in bottles is of the purest kind, and can be confidently recommended.

The supply of oxygen in metallic cylinders is no new industry, for the gas has been obtained for some years in that form. But its preparation was due to the decomposition of certain chemicals—notably that of chlorate of potash, the method of obtaining oxygen from which on a small scale has been fully described in a former chapter. One maker, at least, also obtained it from bleaching powder, by a method it is not here necessary to explain. But until lately the containing bottles were made of iron, and were both bulky and of great weight. Now, however, the cylinders are made of steel of such enormous strength, that three or four feet of gas can be compressed into one little bigger than a wine bottle. But such a small quantity of gas would be of little use to the lanternist, for even at the most moderate rate of consumption, at least four feet per hour must be consumed, unless indeed he cares to economise to such an extent as to impoverish his light. A six foot bottle will then be enough to provide for an evening's entertainment with a single lantern, but when two

Fig. 22.

jets are employed, as in the biunial lantern, a larger cylinder must be provided.

The sizes of the cylinders are stated according to their capacities, and are as follows :—3ft., 6ft., 12ft., 40ft., 80ft. and 100ft. To give an idea of their external size, we may state that the 40ft. cylinder is 2½ft. long and 5in. in diameter. Allowing for the necessary thickness of metal to withstand the enormous pressure under which the gas is confined, its external capacity must be much under one cubic foot. And yet in this small receptacle gas is compressed which would occupy, if free, a space of 40 cubic feet. We may mention that the bottles when first manufactured are subjected to an hydraulic test pressure, far exceeding that which they have to bear afterwards.

Now it is quite obvious that when gas is used for the lantern from one of these cylinders, we have to work under new conditions. Instead of carefully regulating the pressure of the gas by placing one, two, or three weights on a gas-bag, we start with a pressure enormously greater than any we could thus secure. We have, in other words, far too much pressure, and we must do what we can to reduce it to workable conditions. Each cylinder is furnished with a screw-valve or tap, —which is actuated by an attached lever—or in some cases by a key very much like that which is used for tuning pianos. Indeed, the valve-screw terminates in a little square stud, over which such a key can be easily fitted. When gas is required, this valve is unscrewed very gently, some force being necessary to turn it, and it must be noted that it is opened by turning the key in a direction opposite to that in which the hands of a watch move.

Let us suppose, for the sake of simplicity, that we are dealing with a single lantern, *i.e.*, a lantern with only one lime jet, and that we are employing a blow-through jet. The hydrogen side of this jet is connected as usual with the house gas supply. The oxygen bottle can be conveniently placed either in the lantern box, or on a table by its side. It is now connected by a rubber tube with the oxygen side of the jet, a nozzle having been

screwed on to the bottle, over which such a tube can be easily stretched and tied. Now turn on the oxygen tap of the jet *full*, the hydrogen having previously been lighted so as to warm the lime cylinder. It is obvious that now, when the lever tap on the gas bottle is turned, the oxygen will have free passage direct to the lime. And this is a most necessary thing, and for the following reason: Were we to attempt to turn on the gas at the cylinder while the jet tap was closed, the enormous pressure on the rubber tube would either force it from its fastenings, or split it up. In other words, we must regulate the supply of oxygen not by the tap on the jet, but direct from the bottle, leaving the jet tap fully open, and otherwise disregarding it altogether.

This regulation of the amount of oxygen required is not very easy at first, and the tyro should practise the operation once or twice in private before he goes before the public. Let the key on the bottle be moved very gradually, until the effect is seen on the hydrogen flame, then turn on just enough oxygen to give a good light without any hissing noise. When once this is done the gas will require no more attention for about half an hour, when the pressure of gas in the bottle will have become so much reduced by the amount of that consumed, that the key must be gently turned so as to open the valve a little more. Again, in another half-hour or so the same operation will be necessary.

Many good lantern workers object to the use of bottles, because they say they like to see how much gas they have at command; meaning that when they use a bag, they can judge by its bulk how much gas they have. This is certainly a good objection, but one which at once disappears if we take care to provide ourselves with a pressure-guage like that commonly used in connection with steam boilers. This guage can be screwed on a bottle with great readiness; and its indicating hand will show how much gas the bottle actually contains. Thus, suppose that we are using a 6ft. bottle, and that when we receive it, it is full, and charged to a pressure of 120 atmospheres (the pressure of the atmosphere is generally taken as 15lb. on the square inch,

although, we need hardly point out, that it varies according to height above the sea level). We must, therefore, multiply 120 by 15, and we get 1,800. The initial pressure on our gas cylinder is therefore 1,800lbs. on the square inch. But, suppose that we have used some of the gas, and we are anxious to know how much remains. By attaching the pressure-guage we can soon find out. If the guage says 1,500, then we have 5ft. unconsumed; while 1,200 will mean 4ft.; 900, 3ft.; 600 2ft.; and 300, only 1ft. Those who use the large bottles holding 80 or 100 feet, find it convenient to attach a pressure-guage by a T piece to the bottle, or bottles, so that at any moment they can see how much gas there is in reserve. But obviously this is only necessary when work is being done on a very extensive scale.

This necessity of regulating the supply of oxygen direct from the cylinder, instead of manipulating the jet-tap, will at once indicate a difficulty which arises when using a double or triple lantern. For it is obvious that the right amount of gas for one light cannot be made to serve for two or three. This difficulty for a long time stood in the way of the employment of bottled gas for any other than a single lantern. But now more than one ingenious form of regulator has been introduced, by which the amount of gas issuing from the bottle is regulated by the requirements of the lantern operator.

Oakley and Beard's regulator consists of a cylindrical brass box, which screws upon the bottle, and which contains a small bellows of the same shape. This bellows is so connected with the gas supply, that when it rises to a certain height, that supply is cut off, to be renewed directly the bellows sink down again. This bellows really takes the position of a small gas bag, and the supply of oxygen for the lantern is drawn directly from it.

A somewhat similar apparatus has quite recently been introduced, which consists of a tap actuated by a small wedged-shaped bag. This screws on to the gas bottle. As the bag is distended by gas it turns off

the supply, and *vice versa*. With such an arrangement as this the lantern worker is quite independent of gas-bags, and can, if he prefer it, draw both his hydrogen and oxygen from bottles under pressure.

In two important respects gas in a bottle has a great advantage over gas in a bag. In the first place, we need only use just as much as we require, and there is no quarter-bag-full to be emptied away and wasted, as not being worth carrying away. And secondly, the gas will keep without change or deterioration of any kind. Moreover, it is an undoubted convenience to have at hand a supply of oxygen which can at any time be utilised at the shortest notice. On the other hand, gas-bags have their merits, and we must leave our readers to decide which system to adopt. It will well pay some to have both at command.

CHAPTER V.

Dissolving Views.

Having now seen what the lime light is, and having discussed the different forms of jets by which it is made available for the magic lantern, we may now describe the better class of instruments in which the lime light is used. It need hardly be pointed out that directly we part with the simple oil-lit lantern, and come to consider that in which the lime light is employed, we take an immense stride in advance, so far as the consideration of the lantern as an optical instrument is concerned. But it must be noted here that nearly all the lanterns previously described—in fact, all except those which are made for juvenile use—can be so arranged that the lime light can be fitted to them, as well as an oil lamp. This will be found a great convenience to many workers, who, when they want their lantern for home use, will be content with the simple oil lamp; but when giving an entertainment or lecture—it may be for the aid of some charity in their neighbourhood—can

readily adapt the lime light so as to secure at once the advantages of a much larger and brighter picture.

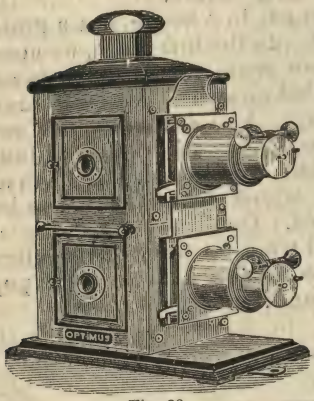


Fig. 23.

We have no need, therefore, to dwell on the construction of the single lime-lit lantern, for it is the same as that lit with oil; with the simple substitution of the lime light jet instead of its normal lamp.

We will now describe the double or bi-unial oxyhydrogen lantern, which represents an instrument which is fitted for the highest class exhibition purposes. As the word bi-unial indicates, the lantern really consists of two in one. There are two optical systems and two jets, one being placed above the other. This position is for the convenience of the operator, so that he can manage both lanterns, without moving from the position in which he stands. (Fig. 23.)

In years gone by, it was the fashion to put the lanterns side by side, and in that case the worker had to flit from one lantern to the other, and so perform double the work that he need do under the present more favourable conditions. These old lanterns, too, had a mechanical dissolving arrangement, which has long ago been superseded, except when oil lit lanterns are used for dissolving views. The arrangement referred to consisted of a couple of metal screens, each being cut in vandykes on one edge. By

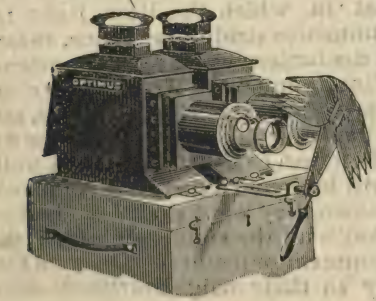


Fig. 24.

a simple lever arrangement, these screens were so moved that while one gradually covered the lens of the right hand lantern, the other uncovered the lense of its neighbour, with the effect that the picture placed in one lantern slowly *dissolves* into the picture placed in the other. This is the whole secret of those dissolving views, as they are called, which made such great sensation when they were first shown, some 40 or 50 years back. No one guessed how the startling effect could be produced, and we may assume that optical knowledge on the part of the public was so very limited, that the secret remained undiscovered for a long time.

But the present method of producing this beautiful dissolving effect is far more simple, and, we may add, economical; for, whereas in the former case both lanterns had to be kept fully lighted throughout the evening, under present arrangements one light is made to sink while the other is brought into full radiance. This act is brought about by the aid of what is called a dissolver, or dissolving tap, which is placed at the back of the instrument. See Fig. 25.

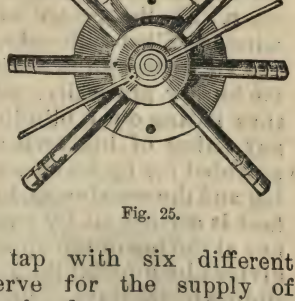


Fig. 25.

It will be convenient to describe this dissolving arrangement before we go further. It consists of a tap with six different apertures, two of which serve for the supply of oxygen and hydrogen from the bags or other gas reservoirs, while two more feed the upper lantern, the remaining two fulfilling a similar office for the lower lantern. The tap is so arranged that when the lever is turned towards the left, the lower lantern is put into action—that is to say, both gases are supplied to the lower jet without hindrance, and when the lever is brought over to the reverse position, the upper jet is so supplied, the other one being turned all but out.

Indeed, the jet not in actual use would be wholly extinguished if it were not for a further arrangement which is provided for in this dissolving tap. It has two small stop-cocks, one on either side, which govern by-passes for both gases. These by-passes are turned on to a very small extent, so that, although one lantern may be dark, there is just sufficient of both gases supplied to its jet to cause a small flame to remain upon the lime. It is obvious that without this provision, dissolving views would be impossible, for when the lever was turned over to supply either lantern, the gases in the other would be extinguished.

With regard to the general construction of the double or bi-unial lantern, we find that it differs somewhat from the single lantern ; that is to say, it consists of something more than two single lanterns placed one above the other. The body of the lantern is in one piece, and is either constructed entirely of tin plate japanned, or is encased in polished mahogany, with a metal lining. Each lantern has a door which, in all good lanterns, is framed, so that no heat can cause it to warp. In the centre of each door is a small round window, filled with coloured glass, so that the operator can view through this window the state of his lime and the burner generally, without opening the door, and thus letting out a blinding flood of light, and without any tiring of his own eyes. Efficient ventilation is provided for by leaving a space between the metal lining and the wooden casing of the instrument, and the heat is carried off by a capacious but ornamental chimney at the top of the apparatus. The two lanterns are divided by a metal floor, and the lime jets are set upon sliding metal trays, which can be moved either towards or away from the condenser—a very necessary provision in focussing the instrument and securing a brilliant disc on the screen in front. The stages of the lantern differ somewhat from the stage of the single lantern, for, whereas the latter is a fixture, the stages of the bi-unial are, to a certain extent, movable ; that is to say, the lower stage, together with the telescopic brass work, which bears the objective lens, can be raised so as to

point slightly upwards, while the upper stage, in like manner, can be lowered to point downwards; both movements being governed by set screws with milled heads. The object of this arrangement is to cause the two pictures from the separate lanterns to coincide in position upon the disc or sheet in front of the instrument. The entire lantern is fixed upon a firm base board of polished mahogany, and during exhibition this board stands upon the box which usually contains the instrument. There is also provision made for raising or lowering the bi-unial lanterns as a whole.

One more piece of apparatus we must now refer to. The double lantern is furnished with what is called a rolling curtain shutter. This is a most valuable adjunct to the lantern, for it gives the effect of a curtain rolling up at the commencement of an exhibition, and of rolling down again at its close. This effect is brought about in a very simple manner. The shutter consists of a plate of brass, cut with an aperture at its upper end, so as to admit the full light from the lime light of the top lantern. At the commencement of the exhibition the lower lantern stage is furnished with a picture of a curtain, generally painted like the drop scene of a theatre, which it is intended to represent.

The upper stage contains the first picture which it is intended to show after this curtain disappears, and by pushing the shutter downwards with an even and slow motion, the curtain has

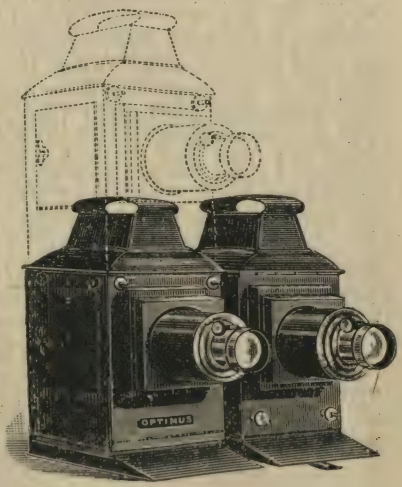


Fig. 26.

the effect of rolling up on the sheet; and as it rolls it discloses the picture. And this curtain arrangement can be well used occasionally in the middle of a series of views, for it allows of a welcome variation in the manner of changing these pictures from one to another, and as a relief from the method afforded by the dissolving tap. When this shutter is in use, the lever and the dissolver must be placed vertically, for when it is in that position both lanterns are furnished with their full supply of gas.

Where an operator usually employs a single lantern but requires the occasional use of a biunial, the type of instrument shown at Fig. 26 can be recommended to his notice, for it can be used singly or as a double instrument. Another advantage in this form of construction is that the lanterns can be used one above the other with the lime light, or side by side with the oil lamp, thus giving the advantage of dissolving views under both conditions.

It frequently happens that in a hall where a lantern exhibition is to take place there is only one available spot where the lantern can be placed, and a certain fixed position where the sheet or screen must be hung. It, therefore, becomes necessary for the operator to calculate the size of disc which can be thrown, and which lens he must use to secure that size. Let us suppose, for the sake of illustration, that the size decided upon as being most suitable is a 15-feet disc, and that the distance which intervenes between lantern and sheet is 45 feet. Divide the size of the sheet by the diameter of the picture used, say 3 inches, thus,—15÷3=5; now divide the distance of the lanterm from the sheet (namely 45 feet) by this product, thus,—45÷5=9. This gives us 9 inches as the focal length of the lens we require.

A table will be found at the beginning of the book, which gives the sizes of discs obtainable by lenses of different foci. Reference to this table will save the operator all trouble of calculation, and he can readily find the position for his lantern.

CHAPTER VI.

How to Manage a Double or Bi-Unial Lantern.

Having now seen in what way the double lantern is constructed, and having also shown the working of the different jets with which it may be fitted, we will next suppose that we wish to place such a lantern in action; and to simplify matters, let us suppose that the lantern in question is fitted with the blow-through type of jets.

Having fixed upon the size of the disc we wish to show—and having well considered the rules which govern the distance of the lantern from the sheet to give discs of varying size—we must place the lantern in position. It is essential that it should be firmly fixed, otherwise the effect of the pictures is very much marred, for if the lantern be at all rickety, as it may be on an uneven floor, every time the operator touches it to change the picture or to move a tap, he will cause a slight vibration of the instrument, which will be terribly magnified upon the sheet, making the pictures appear to move from side to side. To prevent this, the operator should always have at hand one or two wedges, and by using these with judgment beneath the lantern box, he will be able to fix the instrument so firmly that it will not readily move.

The next thing to attend to is the supply of hydrogen, which, as before indicated, is represented by the gas supply for ordinary lighting purposes. An india-rubber tube of sufficient length is attached to the nearest gas supply; but if this be a distance of several feet from the position of the lantern, it is advisable to use some lead piping, such as gas-fitters use. This has the advantage of not giving way when trodden upon, and thus causing the gas supply to be suddenly cut off accidentally. This supply pipe is then connected with the dissolving tap on the lantern. Before anything further is done, the hydrogen can be turned on and lighted at the two jets, the lever of the dissolving tap being placed vertically, so that both taps may be open.

The next thing to do is to so adjust the hydrogen by-pass that when the main lever is turned to the right and left alternately, the lantern which is in darkness has a gas flame about one inch in height remaining. Both taps can now be turned down to that height, while we attend to the oxygen supply. There is a great advantage in lighting the hydrogen first in this way, and it may indeed be thus lighted for an hour before the lantern is actually wanted, for the whole instrument and its lenses will be gently warmed, and thus drive away any moisture which may be on the glasses, and which would be likely to spoil the effect of the pictures. This moisture is always more or less present, especially in cold weather, when the lantern is most commonly used.

We will suppose, for the sake of simplicity, that the oxygen is supplied from an india-rubber bag. This bag should be fully distended with gas, and should be placed between a pair of pressure boards, one 56 pound weight placed on the upper board being quite sufficient for these preliminary operations. The nozzle of the bag is connected by a piece of flexible rubber tube with the oxygen supply pipe of the dissolving tap, and it is advisable to tie with twine both connections, so that there shall be no chance of their slipping away during performance. It is also as well to see that the connecting rubber tubes between the jets and the dissolver are also tied in the same way; otherwise, there may be an escape of gas, which, although it would involve no danger, might bring the performance to an earlier close than was reckoned for. Having all these adjustments made, we can turn the hydrogen tap of one lantern on to its full extent, and then gradually turn the oxygen into it. The two taps require some little care before the exact balance of gases is hit upon ; but this is a thing which a little practice will soon render easy. Next, we must pay attention to the other lantern in the same way, and then we must not forget to adjust the oxygen by-pass, so that just a little of that gas passes to the lantern not in use. The dissolver can then be worked backwards and forwards a few times, in order to see that it is doing its work

thoroughly, and that a good light is supplied alternately to each lantern.

The operator should take care to be cool and deliberate in all his movements, and not to get flurried upon any account. If one light should pop out with a sharp crack, he must not think that there is any danger. It simply shows that either he has moved the dissolving lever too quickly, and therefore brought the gases into operation with too great suddenness, or that his by-passes have not been adjusted properly. These little defects will after a little practice disappear, and he will find that the working of the oxy-hydrogen lantern is not very much more difficult than that of the ordinary oil-lamp. We have supposed in making these remarks that the limes have been placed in position upon the pins provided for them on the jets. These limes, indeed, should be placed there when the hydrogen taps are first lighted, so that they may become thoroughly warmed through before the oxygen gas is turned on. When it is seen that both lanterns are acting properly, we may uncover the lenses, and see what kind of light is being shown upon the sheet. Let us take the top lantern first.

When the top lens is first uncovered, the operator will probably be disappointed at the effect shown, for probably half of the disc will appear bright, and the other half in darkness. This is due to the jet not being properly centred. The operator must raise or lower the jet upon its supporting pillar, until the glare of light appears to be in the centre of the disc, and then by pushing the lime-jet tray towards the condenser, he will find that he can obtain a brilliant disc of light equally illuminated all over. The same procedure will follow with regard to the lower lantern, and then, by means of the set screws on the lantern front, already described, the two systems can be so adjusted that one disc will be super-posed upon the other. Next, we can place a picture upon the lantern-stage, and focus it first of all roughly by pulling out the telescope tube, and afterwards by turning the milled-head focussing screw attached to the front lens.

The lantern pictures usually supplied, measure, as we have noted, $3\frac{1}{4}$-inches square, and are much too small to fit the lantern-stage. Before, therefore, they can be used, it will be necessary to fit each stage with what is known as a carrier. This consists of a wooden frame, which holds a glass picture, and which has been already described in detail.

CHAPTER VII.

The Tri-Unial or Triple Lantern.

Although the double lantern, as we have already said, is well adapted for exhibition purposes, yet to obtain the greatest scale of effects and variations with our pictures we must employ a triple or tri-unial lantern. This consists, as shown in Fig. 27, of three lanterns, one above the other. It represents the most perfect exhibition apparatus which is made, and it is so constructed that the top lantern can be removed if required and used by itself; or the two lower ones can be employed as an ordinary bi-unial; but for exhibitions of the highest class there is no doubt that the complete triple lantern is the instrument to employ. With it the most varied effects can be obtained. Not only can we show ordinary dissolving

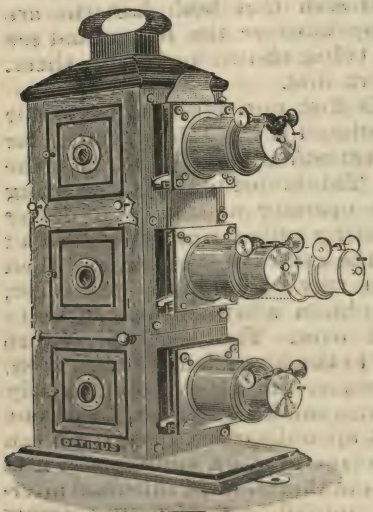


Fig. 27.

views, but we can introduce into these views "effects" by the intelligent employment of the top lantern. This top lantern must indeed be looked upon as an auxiliary apparatus for the production of these occasional diversions, and without it the "effects" that we allude to would be impossible. Let us give one or two illustrations of what we mean.

Let us suppose that in the lower lantern we have a photographic view, coloured so as to represent a summer landscape. In the middle lantern we place a facsimile view, but which has been coloured so as to represent moonlight. By slowly dissolving one picture into the other, a gradual change is brought about, which is sure to please the audience. In the bottom lantern another copy of this same view may be placed, so photographed and painted that, although the view is the same, snow covers the ground, and the trees are bare. We now call in the aid of the top lantern, upon the slide stage of which has been placed a mechanical arrangement, consisting of a strip of silk, pierced with minute holes, and fastened to rollers at the top and bottom. Upon turning on the lantern and rolling this silk strip in an upward direction, little dots of light are conveyed to the sheet, which move downwards, and give a very correct representation of falling snow. We have simply given this as an illustration of the effect which can be produced by using this top lantern in conjunction with others. But this is by no means the only effect of the kind which can be produced. Sets of slides are now supplied which give a great variety of pictures of this kind. A calm sea can be changed into a tempestuous one, and we may have a ship toiling over the waves, and perhaps a flash of lightning striking its masts. Such pictures as these always please an audience, but they can only be produced by means of this complete triple apparatus. A special form of dissolver is necessary with this instrument, and a description of it will form the subject of the next chapter.

CHAPTER VIII.

New Triple Dissolver.

In the use of any form of lantern, other than a mere single one,—that is to say, one possessing a single burner, and one optical system,—it becomes necessary to provide a special form of gas tap, known as a dissolver, by which the gases from one lantern can be transferred to the other without difficulty, so as to produce the favourite "dissolving views." With a double lantern this presents no particular difficulty, for a simple lever tap will do all that is required,—a tap, indeed, which is almost as simple in form as that which turns hot or cold water into a modern bath room. But in the case of a triple lantern, where three optical systems have to be used either separately, or in coujnction, or pair with one another in different ways, a difficulty has always been found in designing any arrangement which should fulfil these conditions. Many systems have been devised, but they are mostly noticeable by their complexity of parts, and by the maze of tubing with which they are associated. Tubes thus multiplied and crossing one another in various directions are apt not only to confuse the most expert and coolest of operators, but are apt to become disconnected, and in that way lead to much inconvenience and disaster. In order to obviate these difficulties, a simple form of dissolving tap has recently been devised, an illustration of which is annexed. It certainly forms a great contrast to previous examples of these dissolving taps. Instead of being bulky, it is compact, and in contrast to the

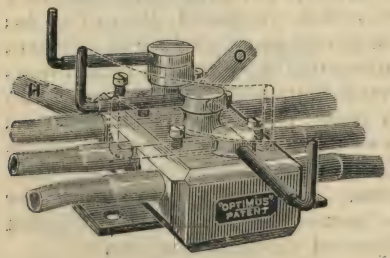


Fig. 28.

confusion of india-rubber tubes already referred to, it has but six outlets, that is, two for each of the three lanterns. Its appearance is that of a small block of lacquered brass, which, instead of being an excrescence, is a positive finish to a handsome lantern. The two supply pipes from the bags or bottles of gas employed are marked in the illustration H and O, respectively, and as will be seen, these pipes descend obliquely from the contrivance. The outlet pipes are connected by india-rubber tubing with the respective jets of the lantern, in order as they stand, that is to say, the pair at the top of this dissolver are connected with the top jet, that in the centre with the middle jet, and that at the base with the lower lantern. A lever, of simple construction and most easy of movement, governs each pair of outlet tubes, and these levers are so arranged that they can be worked jointly by the operator's hand. Thus he can at will employ one lantern only, or he can combine the lower two, the upper two, the top and bottom ones, or all three together. More than this, if from any cause one or two of the lanterns are not required, the levers pertaining to them can be readily locked. There remains to be noticed one other novelty connected with this apparatus, and this refers to the by-pass arrangements. In all dissolving taps provision must be made for causing a small quantity of gas to pass to the lantern or lanterns not actually in use, so that directly these are wanted there is no lighting-up to be done. This necessity is an obvious one in the case of dissolving views; when each lantern is alternately turned off by means of the dissolving tap, a blue flame remains on the jet of the lantern not in use, a flame which owes its existence to the small quantity of gas furnished by the by-pass. In all dissolvers, except the one under review, the by-passes are governed by ordinary gas cocks. These are apt to be touched by a careless operator, or perhaps interfered with by some other hand, and turned on or off as the case may be, to the great interruption of an exhibition. In the new dissolver these taps are absent, their places being taken by ordinary screw heads,

which can only be turned by a screw-driver, or its equivalent. One source of trouble and failure is thus at once done away with, by substituting unobtrusive screw heads for taps, which are both inconvenient and somewhat unsightly. All its parts may be unscrewed for the purpose of being thoroughly cleaned. This dissolver is a great advance both in appearance and lessened weight, and in bulk, upon anything of the kind which has previously appeared; and many experts in lantern work regard it as being a most important invention. In most apparatus, simplicity is synonymous with efficiency, and this is especially true of the magic lantern, where the operator has much to occupy his attention without being taxed with apparatus in which complexity seems to be the chief point aimed at by its manufacturers. The working of this dissolver is so easy that any intelligent child could master it after very brief instruction.

The Ether Oxygen Light.

A new form of lime light apparatus has recently been introduced which is known as the Ether Oxygen Light,

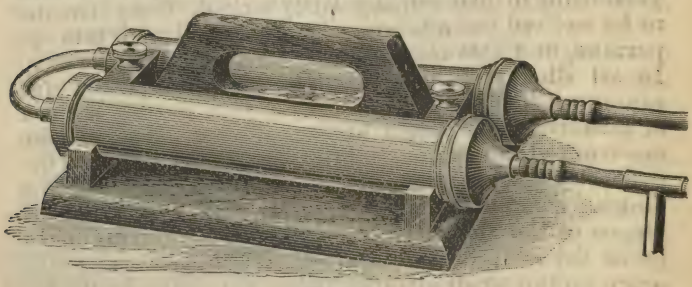


Fig. 29

for the vapour of ether replaces the usual hydrogen. The light afforded by this apparatus is most brilliant, and many workers prefer it to the ordinary lime light. The apparatus employed for the generation of the ether vapour is shown at Fig. 29, and the maker's description of the mode of using it is as follows:—

The Safety Porous Ether Saturator consists of two brass tubes or bodies, screwed into a bent brass connecting tube, lying side by side on an ebonized wooden stand, which is fitted with a handle for carrying about. The brass tubes or bodies can easily be removed by unscrewing the set screws which fasten them to the board Each tube is fitted at one end with screw-down cap, having a nozzle in its centre for the purpose of attaching elastic tubing, and both are fitted with a roll of flannel or coarse cloth, having a spiral wire in the centre to keep them open. Each nozzle has a small screw cap to prevent escape of ether when not in use.

To prepare the saturator for use.—Unscrew the cap from one cylinder, without removing from the stand, hold with open end up, and pour in about 1 lb. of light mithylated ether, until both cylinders are full, then replace the cap and allow to stand in this position for a few minutes. Remove from the nozzles the small screw caps, and pour back the surplus into ether bottle through a small funnel which will receive the ether from both cylinders at once, drain a few seconds, and screw on tightly small caps to nozzles to prevent leakage. It is now ready for use.

To connect to the Jet or Dissolver of the Lantern.—Procure a T of brass tubing and put the single end on the tube leading from the oxygen bag, then connect one of the other ends of the T with one of the nozzles of the saturator, and the other nozzle of the saturator with the hydrogen or ether tube of dissolver or jet. The other end of T being connected with the oxygen side of dissolver, the whole is ready for use.

Precautions.—Be sure that the staurator is well supplied with ether before starting the lanterns. Turn on the ether side of jet first, and as soon as you smell the ether, light up. Then turn on the oxygen side gently and adjust the amount of gases until the best effect is obtained, which should be a most brilliant and steady illumination. Keep a moderate pressure on the bag. In finishing up, turn out the light gently at the jet, and then turn off the gas at the bag, *and not vice versa.* Put soap on all the screws to prevent leakage

of the ether, and *always* use a "mixed gas" jet or burner. The filled saturator should always stand on a nearly level surface to prevent the ether from draining to one end.

Advantages.—Using less oxygen than with other means. Being able to use a "mixed" jet without danger of diffusion of the gases. Having a finer illumination than is given by oxygen and pure hydrogen. The use of only one bag—(oxygen). *Perfect safety in use.*

CHAPTER IX.

The Lantern Sheet or Screen.

We require for the reception of the image cast by the lantern, a white surface of some kind, and although a simple sheet is, from its convenience of transport and the readiness with which it can be fixed in position, the most usual thing to employ, it is not by any means the most effectual surface for the purpose of lantern projection. For a sheet is porous, and allows much of the light to filter through it, and as the light available is of a fixed and limited quantity, all that thus escapes is lost and wasted. The sheet, therefore, if a sheet be employed, should be of thick material, in other words, it should be as opaque as possible.

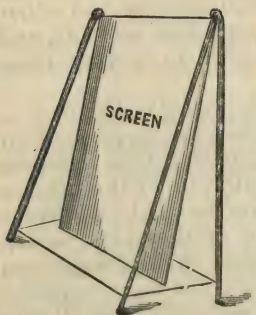


Fig. 30.

For home work, there is nothing better than a sheet which is faced with white paper, which is so fixed on a roller that it can be unrolled and got into position at a moment's notice. A plain white-washed wall would be even better than that, but rather out of place in a sitting-room. For a small picture, a sheet of cartoon paper, which can be bought of any length, and is about six feet in width, forms a capital screen, and one which can be

tacked up on the wall whenever required. For larger screens, and more especially those which are for use in a public hall, a linen or cotton sheet is about the handiest thing to use.

A little judgment is necessary in choosing a position for it, and in hanging it so that it may be as flat as possible. A creased sheet, or one which is hung crookedly, is a great eyesore, and no good operator will be content with such a thing. In order to avoid such an unsightly appearance, certain precautions are necessary. First, secure the sheet by its two top corners, and take care that there is a good pulling strain between them. This is best secured by running a strong cord through a hem at the top of the sheet, leaving a loop at each end. Other cords—previously inserted through hooks or screw eyes, in the walls or roof of the room—are attached to these loops, and the sheet is then pulled into position. Next secure the two bottom corners, taking care that there is a good stretching strain upon them; and lastly, take care of the sides of the sheet.

A good and simple plan of stretching the sides of the screen is as follows:—Get a few common pins of rather large size, and bend them each into the form of a fish hook. Knot a long piece of strong twine to the head of each pin—that is, the shank of the hook—and the arrangement is ready. Now hook a pin into any place at the side of the sheet where a little stretching is required, and pull the cord until the necessary adjustment is made. A tack in the floor or wall will then hold the other end of the twine. A sheet will perhaps want three or four of these attachments—or guy ropes—on each side of it, and they will render it not only flat, but will give it a stability which before it did not possess. The little dodge is a simple one, but like a number of other simple things, it is far more effectual than a more elaborate contrivance might be.

Many operators prefer to carry with them, as part of their stock-in-trade, a portable frame, which can be built up in the room where the exhibition is to take place, and to which the sheet is attached. This frame usually takes the form of a number of stout pine rods,

which fit into one another by metal sockets. There is much to be said in favour of this method of raising a screen, for no ladder is required, and no interference with walls is necessary. Another simple plan for hanging a sheet when it is forbidden to use nails or hooks in the walls, is to plant a ladder at each side of the room, and to make the sheet depend from those supports. Whichever plan be adopted, the sheet should be as flat as possible, and should, if possible, be made to incline forwards. This is because the lantern always requires to be reared upwards, so that its lens or lenses may point to the centre of the screen. Some distortion of the image is the consequence, unless the sheet be sloped, as just indicated, to correct the evil.

The distance of the lantern from the sheet, together with the focal length of the lens in use, will determine the size of the picture shown. It is very necessary that the owner of a lantern should know the rule which governs this question of distance, otherwise, he may have all the trouble of setting up his lantern in the wrong place, a mistake which he does not find out until the jet is lit and a picture tried on the screen. To find, after all this trouble, that the picture is about double the size of the sheet, and that the lantern must be either brought much nearer to the screen, or its lens changed for one of longer focus, is most annoying. Equally tiresome is it to see a picture on the screen of such small size that it looks quite ridiculous, and out of all proportion to the large sheet which has been hung for its reception. All this can be avoided by remembering the following rule, which can conveniently be written on a card tacked within the lantern box :—

Divide the focal length of the lens which happens to be in use by the actual size of the picture shown—by actual size is meant the diameter of the glass slide which is placed in the lantern—say three inches—*then multiply the result by the width of the sheet itself.*

In order to illustrate the working of this rule, let us suppose that we have a 12 foot sheet, and are using a 9 inch lens, at what distance must we place the lantern? The focal length of the lens, 9, must be divided by 3;

as a result we have three—and 3 times 12, the width of the sheet, gives us 36ft. as the correct distance at which to place our lantern. The rule, as will be seen, is simplicity itself, and the operator can easily construct a table based upon it, or refer to the one at the beginning of the book.

CHAPTER X.

Lantern Pictures.

The adaptation of photography to the production of lantern slides, has done more than anything else to make the instrument popular. Those who understand photography—and their number in these days is legion, for amateur photographers are to be found in every town and city in the kingdom—will find it no difficult task to prepare lantern pictures for themselves from the negatives, which they are in the habit of taking for other purposes. There is this advantage in making pictures of the kind, viz., that the smallest-sized negatives are by far the most convenient for the purpose; and when shown by the lantern are, of course, magnified to any reasonable extent. Moreover, nowadays various cameras of small size are made, which are very well adapted for this work. The so-called "detective" cameras, for instance, are usually constructed to take pictures of quarter-plate size. These pictures measure $4\frac{1}{4}$ inches by $3\frac{1}{4}$ inches, and, as a lantern picture is $3\frac{1}{4}$ inches square, the negatives are admirably adapted for lantern slide work. Those who wish to go thoroughly into this matter should buy the accompanying book of this series, which is known as the *Beginner's Guide to Photography*, in which the mode of making lantern slides from photographic negatives is fully set forth. A convenient method is offered, as plates are now prepared which are of such a nature that they can be exposed under a negative to daylight in a printing frame, and the picture gradually becomes apparent under the influence of the light to which the negative is submitted. A few

simple operations permit this picture to be rendered transparent and fixed, when it will form a lantern slide as good as those which can be bought ready prepared. This is known as the *printing out* method of preparing pictures.

Another method which has also been lately introduced is known as the *transferro-type process.* In this case the picture is printed from the negative by gas-light, on a specially prepared paper, called transferro-type paper. This consists of a layer of material, sensitive to light, which is joined to the paper by a soluble cement, consisting of gelatine. The picture is printed on the paper by very simple means, being brought out by the application of a simple developing solution. The paper is then applied to a piece of glass, of the proper size, is dipped in warm water; when the soluble cement melts, the paper is stripped off, leaving the picture upon the glass. It has now to be dried, and is practically ready for the lantern. We have mentioned these two processes in order that the owner of the lantern may be induced to try and make pictures for himself. But as this is not a photographic manual, we do not propose to give detailed instructions here, but must refer the reader for particulars to the manual mentioned.

But a great number of slides can be produced by processes which are not photographic, and this will doubtless have a great charm for those who do not care to take up photographic work, or who have not time to commence operations of a nature which are strange to them. Those who have a little artistic knowledge will find no difficulty in producing slides which will have a good effect in the lantern. One method is as follows:—Procure a piece of finely-ground glass—such glass as is commonly used for the focussing screen of a camera. (The ordinary ground glass is far too coarse.) Draw the design required upon the glass with a very finely pointed hard pencil, such as that marked with six H's, which is made by Faber, for the purpose of drawing upon wood. With a little practice it will be found that it is quite as easy to draw upon this medium as it

is upon ordinary cardboard. There is indeed no difficulty about it. Of course the drawing must be carefully done, because the artist must continually bear in mind that it is to be magnified to a very great extent when in the lantern, and every little blemish will show up in a very disagreeable manner. So the design should first of all be sketched upon paper, so that the artist may be well prepared to know what he is going to do. Having sketched in the outline in this manner it can be coloured with ordinary water colours, taking care that only those colours must be employed which are by their nature transparent. If the artist is used to water-colour work, he is not likely to fall into any error in this respect; but to those to whom colour work is strange, we may as well explain, in a few words, that some tints are perfectly opaque, and that others are naturally transparent. These latter are the colours which must be employed in slide-painting.

A brief list of these colours will not be out of place. For yellow use gamboge; another yellow, but not of such brilliant description, will be found in raw sienna. Chinese orange gives another tint which is implied by its name. For reds, all the lakes and madders may be employed, for they are all of a very transparent nature. Another red, but which approaches brown in tone, is burnt sienna. For blues, Prussian blue and indigo are the colours to rely upon. With these tints, and by judicious mixture one with the other, the artist will find that he has a very wide range of colour. He should get some book upon water-colour painting, by which he can find out how to mix these various colours for foliage, for sky tint, or landscape generally.

When this stage is reached, and the colours have been filled into the outline, the picture should be examined by holding it up to the light. The first thing that will strike the operator is that although he has been employing these transparent tints, the picture, as a whole, is really not transparent enough for lantern work. But he can easily make it so.

We well know that the art of grinding glass robs it of its natural transparence, the surface being roughened

in such a way that every little grain reflects the light, and therefore obscures the medium as a whole. But in the present case we have taken advantage of this roughness as a means for persuading the glass to take "kindly" to the pencil marks and the colour. We can now again make it transparent by a very simple operation. We procure a bottle of ordinary negative varnish, which can be obtained at any photographic warehouse. We must warm the glass, taking care not to make it too hot, but simply to take off its natural chill. Now hold it in a horizontal position, and flow a small quantity of negative varnish over the surface of the picture, guiding it to each corner of the plate, until every part is covered. Do this very leisurely, for there is no need to hurry it. When the whole picture has been thus covered with varnish, pour off the surplus into the stock bottle, at the same time rocking the plate to and fro, so that the viscous liquid shall not form streaks upon the plate. Now once more hold the glass before a clear fire, and this time make it as hot as the hand can bear. The varnish in a few moments will dry perfectly hard, and will to all intents and purposes, form part of the glass itself, taking away its opacity, and making the picture as clear as crystal. Some workers with the lantern have used this plan with very great success, and it is certain that anyone with a little artistic talent can produce, by this means pictures which have a splendid effect upon the screen.

Those who have no time to devote to such work as this must be content to buy their pictures, and they have only to look through a list of the photographs, which are now taken purposely for lantern work, to know what a very wide field of choice they can have. Photographic views can now be obtained of every country in the world, and most dealers sell such views, either separately or in sets. These sets are usually accompanied by a lecture, or reading, descriptive of the pictures, and in many cases, these readings have been compiled by literary men of known ability. Those who have neither the time nor the inclination to pre-

pare such readings for themselves will be quite safe in adopting those to which we refer.

But these readings are not confined to the mere description of places. A large selection of slides of a scientific character can now be obtained, and there are very few departments of science which cannot in some way or other be illustrated by means of the lantern. Looking over a list of such pictures and diagrams which has lately been published, we find that on the subject of "Heat" alone, there are no fewer than 260 lantern pictures prepared for immediate use. In natural philosophy and experimental physics we also find a vast choice of slides. Indeed, the list comprises nearly 500 examples; and although a large number of these are necessarily taken from illustrations which have appeared in the text books, a large number were also prepared direct from nature.

Another subject which is very well illustrated in this way is that of Sound. Then we have slides illustrating the telephone, the microphone, phonograph, electric machines of various kinds, and different applications of the electric light. Indeed, it is not too much to say that any invention, old or new, is now illustrated in these ready-prepared slides for the lantern. There is also a very excellent set of slides illustrating human physiology. These subjects are all accompanied by readings of a popular and reliable nature.

Astronomy happens to be a subject which can be particularly well illustrated by means of the lantern, and here the amateur can himself prepare a great many slides of a very effective nature by employing very simple means. There are many books on astronomy, which give excellent diagrams. For instance, we shall find a number of valuable illustrations in the numerous works by the late Mr. Proctor. Then there is a very large volume on *Popular Astronomy*, which has recently been written by the Royal Astronomer for Ireland, Sir Robert Ball. By looking through such works as these, we find a number of illustrations which can be readily applied to lantern purposes, without the aid of photography, and, indeed, without even such

trouble as is involved in the ground-glass method of slide making, to which we have referred.

The late Mr. Woodbury, of photographic fame, pointed out how a number of these astronomical diagrams could be prepared in the simple manner to which we have adverted, and the hints he gives are very valuable. He suggests that slides illustrative of different constellations as well as the planets may be produced by using blackened cards ; and by punching holes in them or pricking holes with a needle. With a little more trouble the various nebulæ can also be represented.

The first operation will be to choose an illustration in one of the astronomy books, of say, a constellation ; we mark out on the blackened card with a pencil, the outline which it forms, and then we prick in the different stars composing it, with needles of different sizes. In representing the planets, we shall of course require somewhat larger holes, and then punches of different sizes will come into use. Little bits of gelatine, such as we usually find on the crackers at a Christmas party, will be useful in filling in some of the holes, so as to distinguish the different planets by their colour, and also in illustrating such a subject as that of coloured stars. (We may observe here, that coloured gelatine, is for all purposes, far more serviceable than coloured glass, for the reason that it transmits far more light than the glass.) The orbits of the planets can be described by needle pricks, placed very close together. Such slides as these are really effective upon the screen, and as a matter of fact, they are very much more brilliant than those on glass, for the reason that the light naturally shines with far more intensity through an open aperture, such as a needle-prick, than it can through an aperture which is scratched upon a blackened glass.

CHAPTER XI.

Mechanical Slides.

Under this head we group all those slides, mostly of a humorous character, which are prepared more

especially for the amusement of children, although it must be confessed that their elders are by no means averse to witnessing the effects produced by them. The simplest form of mechanical picture is known as a comic slipping slide, so-called because it consists of two glasses, one of which is fixed, while the other, placed above it, is movable,—that is to say, the latter slips from left to right or from right to left, as the case may be. Thus on the fixed slide we may have the figure of a man with a long nose, but most of this member is

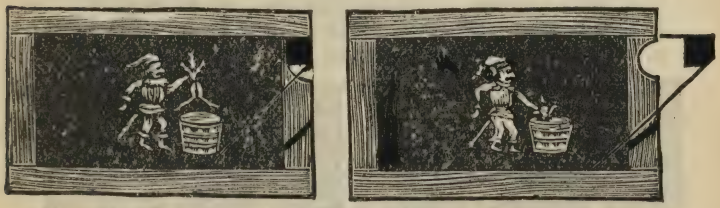


Fig. 31.

covered by the slipping glass in front, which is painted with a black shield, so as to screen it. This upper glass is now manipulated from the outside of the lantern, and slipped on one side,—that is to say, so that the gentleman's nose is suddenly seen to elongate in a very laughable manner. The designs which are sold and which are actuated in this manner are endless, and they never fail to bring the greatest delight to a juvenile audience.

Another form of mechanical slide is that which may be described as a panorama slide. Thus we may have, as a fixed picture, a design representing Noah's Ark,

Fig. 32.

while in front of this is moved a long slip of glass upon which is painted the different animals, walking two and

two in procession. Thus the animals on the sheet appear to walk in review order, in front of the structure which they are destined to inhabit for so long a period.

Another kind of mechanical picture is known as the lever slide, and in this case we have a fixed picture with a movable glass resting upon it, which is worked by a lever at the side. For instance, we may have a man painted on the fixed slide, while his arm, with a cudgel or a pitch-fork, whichever it may be, is painted on the movable glass. By working the lever up and down, the man is seen to move his arm in a very natural manner. Or the same device may be applied to the picture of a horse drinking, the neck of the animal

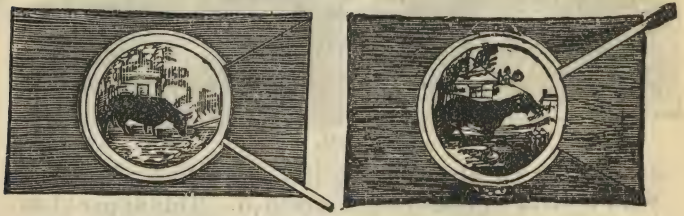


Fig. 33.

being painted on the lever glass, to be moved up and down as he puts his mouth to the trough. In some cases the lever arrangement is combined with a slipping glass, and most comical effects are produced in this way.

Some mechanical slides are furnished with a rack work motion. For instance we may have a landscape, with a mill in the centre. The sails of this mill are painted upon another glass in front, which is caused to revolve by rack work, by turning a handle which projects outside the lantern stage. It need hardly be pointed out that a water mill can be worked in the same manner, giving a very natural effect on the

Fig. 34.

screen. And this rack work motion brings us to the consideration of another favourite lantern device,—viz., the Chromotrope. In this case we have a double motion.

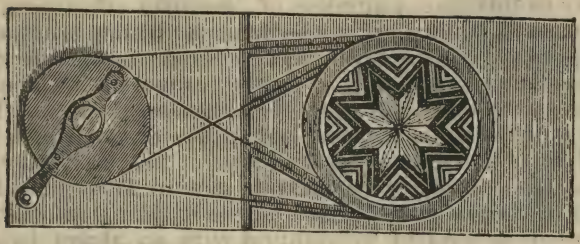


Fig. 35.

The glasses are round, and on each one is painted a geometrical design. By moving a handle these two designs are caused to turn in opposite directions, giving a wonderful kaleidoscopic effect upon the screen. Most gorgeous effects can be produced by using these chromotropes in the double lantern, for while both are working one can be slowly dissolved into the other, and in this way endless changes are brought about.

The chromotrope effect forms a very great relief to a lantern entertainment, and is often used to divide subjects from one another. Their exhibition serves, too, to give the reader a few minutes respite.

CHAPTER XII.

STATUARY.

PERHAPS no pictures can be better shown with a lantern than photographs of statuary. These are now prepared in endless variety, and it is not too much to say, that any well-known statue, either ancient or modern, can be obtained in the form of a lantern slide. These pictures are usually blocked out,—that is to say, every portion of the photograph but the statue itself is covered with black opaque pigment, so that the statue

stands out upon the sheet as a solid reality. Such pictures can always be shown by means of the single lantern; still better can they be shown by a double. For in this case a number of beautiful effects can be produced, by using in the lantern which is not employed for the slide different coloured screens. In this way the most varied tints can be thrown on the statues, increasing their effect to a very wonderful extent. But in order to show statuary to the greatest perfection the triple lantern must be employed. The best way to exhibit statuary with a triple lantern is to have two separate slides, besides the picture itself. One will represent a kind of proscenium with an alcove in the centre, which at first appears to be filled in by a curtain. This curtain is really placed in the second lantern, and by a mechanical device can be raised up, discovering the statue which is in the third lantern, apparently behind it. When one slide has been thus shown, the curtain is seen to descend, and the slide is changed; when it re-ascends a fresh statue is under the alcove. Many exhibitors make a rule of concluding a performance by an exhibition of statuary of this kind. It is as well to include in such an exhibition a few statues of a distinctly humorous kind, such as the "Dirty Boy," and other statues of a like character, and it is also usual to conclude with a statue of Her Majesty the Queen.

CHAPTER XIII.

LANTERN EXPERIMENTS.

THOSE who wish to use the lantern for the purposes of education—for which it is so admirably adapted—will be glad to find that the instrument is not only capable of showing pictures and diagrams, although we need hardly point out that such pictures can be very well turned to educational uses, but that a number of interesting and valuable experiments are also possible by its aid. For these experiments the lantern stage should be open at the top, and many lanterns are now made with this modification.

We will begin by reviewing what are known as "tank" experiments, for they are performed by aid of a little tank, or cistern, which is placed in the lantern stage, where the lantern picture is ordinarily put. This tank is of very simple construction. It consists of a mahogany frame, pierced in the centre, with a 3-inch orifice, which is filled in with two sheets of thin glass, separated by a piece of india-rubber tubing. This india-rubber, when the two glasses are held together in the mahogany frame, constitutes a water-tight joint; and this mode of construction has the further advantage of allowing the apparatus to be readily taken to pieces, so as to be cleaned. It is advisable that the operator should be provided with three or four of these tanks, because they are used for chemical solutions, and it is obvious that one might contaminate the other, and naturally there would be no time for cleaning a single tank between each experiment.

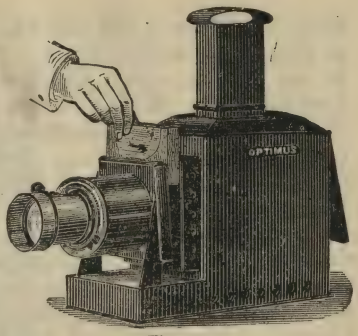


Fig 36.

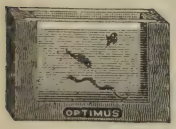


Fig. 37.

We will now detail a few of the experiments which are possible by the use of this tank; and when the operator becomes accustomed to its use, a great many more will occur to him, especially should he have a little knowledge of chemistry. Perhaps the most simple experiment to begin with, will be to show the method by which a chemical solution, whether alkaline or acid, can be tested. This, as many of our readers will know, is ordinarily done by means of a piece of paper stained with litmus—the blue colour of which turns red if the paper is dipped into a solution which has the least trace of acid in it. But we modify this method when using the lantern tank. First of all, fill it with a solution of litmus, which will, of course, show a blue

disc on the screen; and now add to it, by means of a pipette, a little dilute acid, when it will be found that the portion of the solution which the acid first meets, will turn red until the whole of the contents of the tank change colour. With another pipette we can add to the reddened solution a little ammonia or other alkali, when the original blue colour will be restored. A solution of purple cabbage will behave in exactly the same way.

Another pretty experiment is performed by filling the tank with very dilute sulphuric acid—say one part of acid to eight of water—and then dropping into the tank a small piece of zinc. The metal immediately begins to dissolve in the tank, with evolution of bubbles of hydrogen gas, which rapidly rise to the surface. On the screen this action is of course reversed, the black shadow of the zinc appearing at the top of the disc and the bubbles flowing from it in a downward direction.

We can show the production of carbonic acid gas, in the same way, by substituting for the sulphuric acid a dilute solution of muriatic acid and dropping into the tank a small piece of marble or chalk. In connection with this last gas we may wish to show that it is given off from the lungs in the act of breathing. To show this, fill the tank with lime water, and, by means of a bent glass tube, blow into it with the mouth, when the solution will speedily become cloudy, in consequence of the formation of carbonate of lime.

We can also illustrate the manufacture of ink by filling the tank with a solution of sulphate of iron; to this must be added, in the usual manner, a solution of gallic acid, when black clouds of ink will immediately be formed. Another very pretty experiment, which shows the presence of certain salts in hard water, is performed by filling the tank with such water—that is to say, ordinary drinking water as it comes from a spring, or as supplied to the household—and suspending in it a crystal of oxalic acid. This can be tied to a silk thread, and easily hung in the tank by means of a little bar of wood placed over its top. It will then be seen that long opaque threads of oxalate of lime are being given off, by the crystal of oxalic acid, until the water becomes opaque.

Another experiment, which can be performed with the infusion of cabbage already alluded to, and which, by the way, is made by slicing a little of the vegetable and pouring boiling water upon it, can be exhibited thus: A few drops of alum added to the solution will turn it purple; in another place a little potash solution will turn it green; while a drop of hydrochloric acid will make it crimson. If these experiments be carefully performed, and the three solutions ready at hand in three different pipettes, the effect upon the screen is very beautiful; for, although the drops really move downwards in the tank, they appear in the reverse direction on the screen; and look like wonderful arborescent forms of different colours growing up from the lower part of the sheet.

The bleaching action of what is called chloride of lime, but the proper name for which is bleaching powder, is shown well by adding a weak solution of that chemical to a tank full of solution of indigo, to which a little sulphuric acid has been added; the acid will set free the chlorine, and the colour will be gradually discharged.

We have, for want of space, mentioned only a few of the experiments which can be performed with this tank; and the operator, by consulting a manual of chemistry, will be able to arrange a great many more of the same kind for himself, and the intelligent use of the tank in this way will prove that the little contrivance is of great educational value.

We can also use the tank for a few experiments of an electrical nature. For instance, the gutta-percha wires from a small battery—a bichromate cell is quite sufficient for this purpose—are so arranged on each side of the tank that their bared ends almost meet. The tank is at the same time filled with dilute sulphuric acid of the strength already given. Directly the battery is put in action, bubbles will be seen to arise from each terminal, the bubbles from one being those of hydrogen gas, and from the other wire oxygen gas. This experiment shows in a very neat manner the decomposition of water into its constituent gases. We see in this experiment, perhaps more than any others that we have named, the great economy, if we may put it so, in using the lantern for experiments; for in order to show this

decomposition of water effectively on a lecture table, we want not only apparatus of a large size, so that many can see it, even though at some little distance from the table, but we also want a powerful battery to give it due effect. In the lantern, on the other hand, by using the simple apparatus explained, we use only a single battery cell, and everything is done on the smallest possible scale, the lantern giving the necessary magnification which is requisite for showing the experiment to a large audience.

With this same battery and tank arrangement we can also show one or two other electrical experiments. For instance, we may fill the tank with nitrate of silver, keeping the tubes in the position already noted. When the current commences to flow, we find that one of the wires has gradually growing upon it a silver tree. We may vary this experiment by filling the tank with a solution of acetate of lead, when metallic lead is formed in the same way.

The tank also affords a ready means of showing capillary attraction. One way of doing this is to arrange four small glass tubes, each having a different bore, and being graduated from the largest bore, on one side diminishing to the one with the smallest bore on the other. These tubes may be conveniently inserted into a rod of mahogany, and arranged so that their lower ends are exactly parallel with one another. Fill the tank only half-full with plain water, and then dip the tubes into the vessel, the result being that the water is attracted up the tubes in varying degrees, the smallest tube showing the water rising to the greatest height. Another way of showing capillary attraction is to arrange two plates of glass, wedge shape, on a small piece of mahogany, and when this is dipped in the same way into the half-filled tank, the water will be seen to creep up between the glasses, forming a distinct curve. We need hardly point out that such experiments could not be so effectively shown by any other means, unless it was for the gratification of one or two spectators only.

Very beautiful effects can be shown illustrative of the phenomena known as cohesion figures. Fill the tank with methylated spirit, and then take a little aniline dye in strong solution on a brush, and touch one of the inner sides of the tank with it, so that a little drop of the dye may just fall

gently into the spirit. Directly this drop meets the alcohol, it will spread out into wonderful figures, which look on the screen like a marvellous arborescent growth. We may vary this experiment by using one or two different colours, in different parts of the tank, at the same time, when the result on the screen is simply magnificent.

A very beautifnl series of experiments in optics are possible by attaching to the lantern a polariscope, such as that shown in Fig. 38. But these experiments in polarized light are more suitable for the advanced students in optics than for general audiences, the phenomena illustrated being somewhat complex and not admitting of very popular treatment.

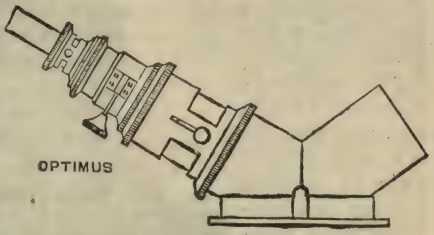


Fig. 38.

That wonderful modern instrument of research called the spectroscope, which has of late years unlocked so many secrets of nature, is also applicable to the lantern. But although a limited amount of work can be done with it by the help of the lime light, to attain any perfect results the more powerful electric arc-light must be employed. When electric lighting becomes more general the employment of this form of apparatus will present no great difficulty, for the current to feed it will be at hand.

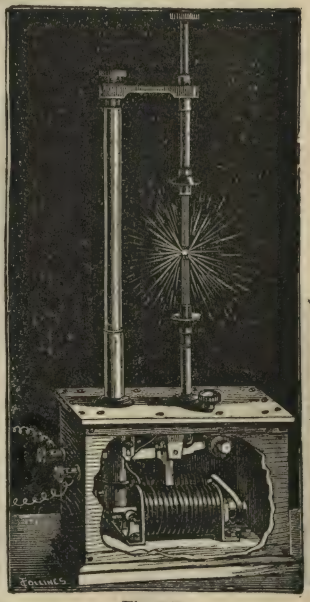


Fig. 39.

Anticipating that time, illustrations are appended of the apparatus which has been devised for this work. Fig. 38, shows the form of arc-lamp or regulator, which has been found efficient for this purpose. Fig. 41 is the electric lantern, lens, and prism used for exhibiting the spectra of different metals, &c., and Fig. 40 is a more perfect form of lantern, having two nozzles, one furnished with a slit for spectrum experiments, and the other having an ordinary objective for the more usual work of lantern projection.

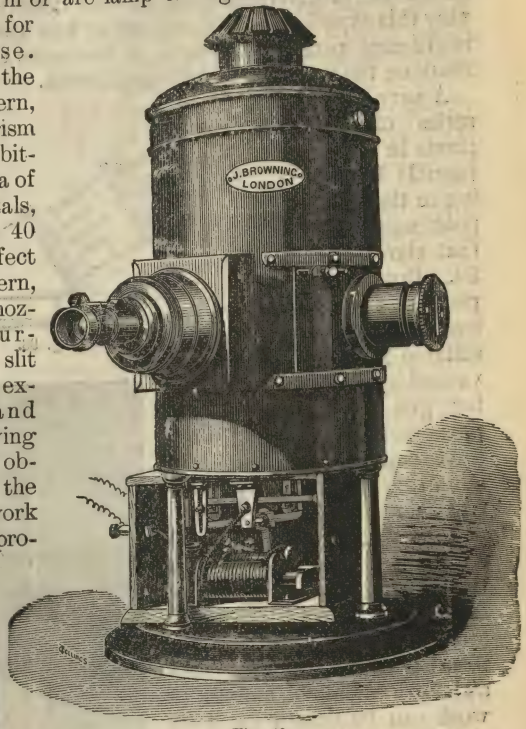


Fig. 40.

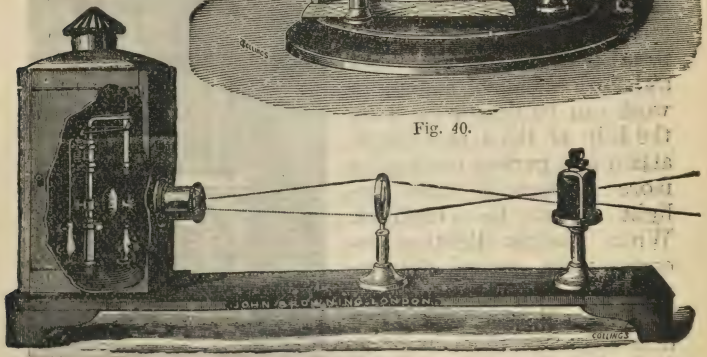


Fig. 41.

The Microscope.

A very useful adjunct to the lantern is the microscope, of which are known two forms, Fig. 42 and Fig. 43. The microscope is an instrument which is now a favourite source of study with many earnest workers; and perhaps its greatest disadvantage is found in the fact that it is for the individual eye of the observer, and that the eye requires much education before it can be trained to appreciate the wonders exhibited by it. But if we can so modify the instrument as to attach it to our lantern-front in place of the usual objective lens, its functions are enormously increased, and it at once becomes a source of pleasure and instruction to the many instead of the few.

Fig. 42.

The lantern microscope has evidently been evolved out of the solar microscope, which was in use some fifty or sixty years ago. This instrument was so fitted in a wall, or darkened window, that a mirror outside would reflect a ray of sunlight through it, and thus enable the image of roughly prepared preparations to be projected on a screen within the room. The instrument was as imperfect as it was inconvenient; more than this, the sun is such an uncertain source of light in these latitudes that it is clear that an instrument depending upon its direct rays could not often be employed. But the lime light makes us quite independent of such fickle aid, and the microscope, therefore, becomes a most important feature of lantern work. Any microscopic preparations are suitable for it, provided that they be bold in character and very transparent.

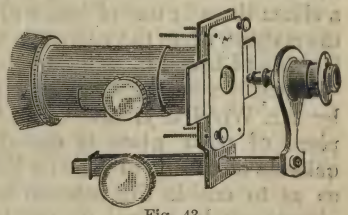


Fig. 43.

There are a few interesting experiments of a magnetic nature, which can be shown very well with a lantern, and here again we see the advantage of the wonderful magni-

fying power that we have at our command. Under ordinary conditions to show magnetic experiments you require not only a powerful electro-magnet, but a troublesome and expensive battery with which to put it into action. But with a lantern, we need only employ a very small electro-magnet, consisting of a bent piece of soft iron, with a reel of silk-covered copper wire on either pole; the iron being so bent that the two poles are brought within half an inch of one another in the centre of the slide. By dropping iron filings from above on to these poles, we can first of all show that the apparatus has no attractive power whatever until it is in connection with the battery. We may now make that connection, and once more drop the particles of iron upon the poles, and they will fly to the two poles of the magnet, and as they continue to be dropped they will gradually bridge the poles across, with a mass of attracted filings. When the battery action is cut off these filings immediately drop.

Another good experiment may be arranged to illustrate the difference between magnetic and dia-magnetic substances. For this we shall require two little discs of metal about the size of a threepenny piece. Each is suspended on a silken thread; one of iron will set itself at right angles to the magnet when the current is applied; the other one, which is made of bismuth, will take the reverse direction.

There is a beautiful colour experiment which was devised by Mr. Woodbury, and which is performed as follows. A piece of clear glass is coated with a strong solution of chloride of cobalt, to which a little gelatine has been added so as to enable the solution to remain on the glass. A picture can be placed on the lantern stage in conjunction with the glass so prepared, and it will give the view a beautiful rosy effect, but as the chemical gets gradually dry, by the heat from the lantern, this rosy tint will change to bright blue. On placing the glass in a damp atmosphere the rosy colour will be restored, so that a glass so prepared, if it be used with care, can be relied on for producing the effect over and over again.

Those of our readers who happen to be photographers will be able to show in the lantern the wonderful effect of the gradual development of the photographic image. The

experiment requires great care; but it is by no means difficult to those who are accustomed to photographic manipulations.

For this experiment we must again have recourse to a tank which must be very carefully cleaned, as should there be any traces of previous chemicals in it, the experiment will probably fail. Our first care must be to procure a gelatine plate of the proper kind—the ordinary bromide plate is no use here, for it is so sensitive that the light from the lantern would defeat our purpose altogether. We must employ a plate which has been coated with gelatine *chloride* emulsion, and such plates are now sold for the manufacture of lantern pictures. They are several hundred times less sensitive to light than bromide plates, and are therefore very suitable for the purpose which we now have in view. The plate must first of all be exposed in a printing frame under an ordinary photographic negative, and the best kind of negative to employ is one which bears the image of a portrait, and if the portrait be one which is familiar to the audience all the better. Place the negative in the printing frame, with a chloride plate against it, film to film. This can be done by gas light in the presence of the audience. Now burn an inch of magnesium wire at the distance of about one foot from the printing frame. This will be quite sufficient to form a latent image on the plate. Now have ready a tank in the lantern, and against its inner side—that is, next to the lantern condenser—place a piece of deep orange or red glass. This is to protect the plate from the action of the lantern light. Fill the tank nearly full with developer, which must be of the kind known as ferrous oxalate.

Now place an exposed plate in the tank, taking care that it is upside down, with regard to the latent image which is impressed upon it. Gradually this image will begin to appear on the sheet; and if the experiment has been intelligently performed, the audience will quickly recognise the portrait. Now remove the tank, rinse the plate in a basin of water, which should be in readiness for the purpose, and place another tank in the lantern, filled with a fixing solution of hyposulphite of soda. Replace the plate in the second tank, remove the red glass, and the image will quickly clear, and will show brilliantly upon the screen. There is

no experiment that is more effective than this, if it be carefully done; and it is sure to meet with a great deal of surprise and admiration on the part of the assembled spectators.

A far more simple series of experiments can be performed without any chemical solutions, and by the aid of a few sheets of coloured gelatine and pieces of black paper. These experiments are designed to show the theory of colour. For instance, we may take two pieces of card, and pierce three holes upon each of them, filling these holes in with the three primary colours—namely, red, yellow, and blue. By placing these two cards in a chromotrope frame,—which, as we explained in another chapter, is furnished with rack work, giving reverse motion to two pieces of glass placed within it—these colours may be made to overlap one another, forming secondary tints. Thus the yellow overlapping the red will form orange; the red overlapping the blue will form purple; and the blue overlapping the yellow will form green. A great many experiments of this kind will readily occur to the operator. Another curious effect to be produced by simple means is to show what is denominated "persistence of vision." This persistence may be explained in the following way:—The image of everything we see remains upon the retina of the eye for a small fraction of time, after we cease to look at the object in question. We well know that a stick with a lighted end, if it be twirled rapidly round in darkness, gives us the impression of a ring of fire, although we know very well that it is a moving spark. The beauty of most fireworks is derived from this curious persistence of the image upon the retina; and many of them would quite lose their effect if it were not for this curious phenomenon.

In order to apply this to lantern experiments, we may take a piece of blackened card, and pierce it with concentric rings of holes of different sizes. By setting this card on a spiral spring fixed in a mahogany frame, and just flipping it with the finger, the card is made to vibrate and dance, and the little spots of light mingling with one another upon the retina, form all kinds of curious patterns and devices.

In connection with complementary colours we may, too, show how, when the retina is tired by observing any parti-

cular tint, the ghostly image of the design looked at, only in its complementary colour, is seen. We very often experience this effect in Nature when looking at the red sun sinking in the West. Upon taking the eye suddenly away, and looking at another part of the sky, we see a spectral green sun. This same effect can be produced in the lantern in the following way:—Upon a piece of coloured gelatine or glass, place a cross or other device, cut in black paper. Throw the image on the screen, and invite the company to gaze fixedly at it for a minute or two. If the background be green, the audience will see a red cross when the image is suddenly shut off, and the screen is illuminated with a plain light from another lantern; or supposing that the double lantern is not in use, an ordinary lamp or candle flame, placed near the screen, will give the same effect. If the background has been blue, the device will be seen as orange; and if the background has been red, the spectral image will be seen of a green hue. Here, again, we must point out to the operator how such experiments can be varied in many ways. In this chapter we have not attempted to give a complete review of all the experiments which are possible with the lantern; but we have endeavoured to guide the operator in the direction of such experiments, and to show how they can be performed.

CHAPTER XIV.

The Aphengescope.

Some people may regard it as a disadvantage to lantern work, that the only pictures which they can exhibit are those which have been specially prepared as photographic transparencies on glass, or as paintings, also transparent, which have been executed by hand. They will perhaps say that they want to produce on the sheet enlarged images of the photographic portraits from their albums, and although they may be aware that these portraits can be copied and made into lantern slides, still they will not consider that the result

obtained is worth the trouble and expense involved in such transmutation. Such persons will therefore be glad to know that by a simple addition to an ordinary lantern they will be able to project images of any carte-de-visite or other photograph upon the lantern screen, and that such images are not limited to mere photographs, but will comprise all kinds of objects of an opaque character. For instance, the operator may have a cabinet of shells, or of minerals, which he may desire to show to his friends; or perhaps he may have a valuable collection of coins or medals, and these he may wish to exhibit in the same way. Such things, as a rule, and under ordinary conditions, can only be examined by one person at a time, and as they are handed from one to the other. But by the addition to which we have just adverted, all these objects, and many others too numerous to mention, may be exhibited by means of the lantern. The necessary attachment to which we refer is the aphengescope.

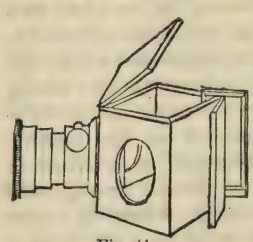


Fig. 44.

The first idea of this instrument was evolved from what used to be called the opaque lantern, which was introduced more than 20 years ago, for the express purpose of showing photographs on paper, and other opaque pictures and preparations upon the lantern sheet. But this instrument was as expensive, if not more so, than an ordinary complete lantern, for it comprised not only a complete lime light system, but also in the more perfect form of the instrument, two large condensers, besides an objective lens. In order, then, to reduce this expense, the aphengescope or opaque lantern attachment was devised. This contrivance will fit on to any ordinary good lantern.

A single lantern will answer the purpose; but if we have a double lantern which will take apart, so that its two systems can be used separately, we can, by means of this aphengescope, get a far better result. The

ordinary objective is removed, and in place of it is fitted upon the lantern a kind of angular box, so that the full light from the condensing lens or lenses is thrown into the interior of that box. In this receptacle is placed the opaque photograph or other object to be shown, while exactly opposite it is screwed the objective lens of the lantern, so that the image of the brilliantly illuminated object is projected by the lens on to the sheet. In other words, instead of a brightly illuminated transparent picture, we have a brightly-lit opaque picture, and the lantern objective lens is called upon to do the same work in both cases, that is, to form an image of that brilliant picture upon the screen in front.

The aphengescope can be fitted to an oil lantern if desired: but as may be naturally supposed, there is a good deal of light lost by reflection, and a lime light will, therefore, give a far better effect, for there is more light to spare under such conditions. There is no doubt that a great deal of amusement can be obtained from this form of instrument, for photographs of friends can be slipped out of the album in which they are usually contained, and can at a moment's notice be placed in this apparatus. The owner of such an attachment can, too, readily exhibit all kinds of different objects which have, some of them, a very curious effect on the sheet. Any fruit cut through, so as to show its interior parts, forms a very interesting object, as shown with the instrument. For instance, we may take the half of a freshly-cut lemon or orange, and while its image is thrown upon the screen, by giving it a gentle squeeze, the pips are seen to fly upward, while the drops of juice take the same direction, for it must be remembered that the lens is the same as the one which is ordinarily used in lantern work, and therefore everything is inverted by it. In showing medals or coins, a far more beautiful effect is possible with this opaque lantern than any mere photograph used as a lantern slide would afford in the ordinary lantern, for the light striking the various polished projections of the medal, gives them a brilliant sheen, which is

faithfully transmitted to the screen in front. Another interesting object to show is the working movement of a watch—that is to say, an ordinary watch can be opened, so as to show its movements. This watch can then be hung in the place where the pictures are usually put, and the enlarged image of a timepiece will appear on the screen, with all the wheels in movement, and with the different parts of the metal work sparkling with light. A freshly-opened oyster also forms a remarkable object. It need hardly be pointed out, that for lecture purposes or educational service generally, this aphengescope is a really valuable addition to the lantern.

Concluding Hints.

The lantern, although of the best and strongest make, must be treated with that care which is requisite in dealing with all philosophical instruments, and which is more especially demanded by those of an optical nature. For lenses are easily injured, not only on account of the brittle nature of the material of which they are necessarily made, but also because of the readiness with which they can be scratched. Such a blemish on the objective lens, although undesirable, is not of half the importance which one assumes if it be on the condenser. For, in the first case, the image of the defect is not transmitted to the sheet; while, in the second case, it becomes magnified there into an eyesore, which will spoil the effect of every picture.

Fracture of the condenser can be brought about not alone by careless handling. As already pointed out, a deeply pitted lime will sometimes cause the flame to be reflected towards the glass, in which case the condenser is sure to split. Care should be taken to avoid draughts when the light is put out at the close of an exhibition, or the same thing may happen. For the condenser gets intensely hot, and the sudden access of cold air may be fatal to it. Keep, therefore, the door of the lantern closely shut for some time after the light has been extinguished, so that the glass may gradually cool down. Condensing lenses are invariably set rather loosely in their cells to allow for the expansion which glass, in common with most other bodies, undergoes

in the presence of heat. Scratches may be caused by the condensing lens slipping out of its place during travelling, to avoid which it is as well to have at hand thick woollen pads to place against the glasses inside the lantern when the instrument is not in use.

The brasswork of a lantern will keep its lustre for years if it is occasionally lightly rubbed with a wash leather kept for the purpose. It should not be treated with any plate powder or anything of the kind; for, although an added brilliance may be thereby gained for a time, the lacquer will most surely be removed by such treatment, leaving the unprotected metal to become quite black from exposure to the air. All polished brasswork receives a coating of this varnish, or lacquer, before it leaves the workman's hands, and removal of this necessary protection results in the baneful effect just named

It is a good practice to thoroughly overhaul the lantern at the beginning of winter, and to see that all its working parts are in order The lenses and je should first of all be removed, and the inside of the instrument well dusted, and afterwards carefully sponged with hot water. The india-rubber tubes should then be carefully examined for signs of wear, for no one has yet discovered the secret of making india-rubber imperishable. The best quality will go after a time The jets may next come under treatment. The taps should be unscrewed and cleaned with hot water, a copious supply of which should be also poured through the tubes. All the different parts should then be well dried, and before the taps are replaced the smallest quantity of tallow or vaseline thould be smeared on their plugs. The dissolving tap should be subjected to a like treatment. If pure hydrogen were available, all this care would not be necessary; but as the carburetted gas used in our houses is from its convenience generally employed for lantern work, and as it carries with it many impurities, the pipes suffer unless this cleaning process is occasionally carried out. The use of impure chemicals for the manufacture of the oxygen will also sometimes cause a deposit in the tubes; but this difficulty happily is of rare occurrence, for such bad material is not often met with.

After use, the lime cylinder should always be removed

from the jet, and returned to its original tin box, or to one kept for the purpose. If left *in situ* it will soon crumble to dust, and make an unnecessary mess in the lantern. Moreover, as we have pointed out in a previous chapter, these discarded limes are useful for purifying the gas. The limes should be handled as little as possible, for they are of caustic quality, and burn the flesh. It may also be observed that the dust from them, if it get into the eye, may be productive of serious injury. A pair of tongs for removing hot limes is a very useful adjunct to the few tools required by the worker.

A few hints as to tools necessary will not be considered out of place. A hammer and a screw-driver come first, as most indispensable things. Next we shall require a bag of tacks and nails, some good strong iron screw eyes, and one or two hooks or holdfasts. These are for hanging the sheet in case a portable frame is not at hand. Cording and a ball of string will be wanted for the same purpose A pair of gas pliers, to remove refractory gas fittings, is also an indispensable tool; and as aids to this part of our work, we should also carry with us extra india-rubber tubing; short metal tubes to serve as connections; a reducing socket, by which a pipe of small bore can be screwed to a larger one; and one or two odds and ends of gas fittings, such as a T piece, an L piece, &c., which are sure to come in useful. All these articles can be kept in a small, strong bag, which can be packed easily with the other apparatus.

WOODFORD FAWCETT & Co., Dorset Works, Salisbury Square, Fleet St., London.

DISC DIMENSIONS WITH OPTICAL LANTERN OBJECTIVES.

Supposing we are called upon to use a magic lantern in a hall 25 feet in length, we first ascertain the site of disc desired, which we will suppose to be 10 feet. With an objective having a focus of 6 inches, how far from the screen must the lantern be placed in order to produce a 10-feet disc?

Here is the rule by which it can be ascertained :—

Let A = focus of objective.
„ B = diameter of slides.
„ C = diameter of disc.
„ D = distance between lantern and screen,

Multiply the diameter of the circle required (C) by the focus of the lens (A), and divide by the diameter of the slide (B).

$$\frac{C \times A}{B} = D = \frac{10 \times 6}{3} = 20 \text{ feet.}$$

It is thus seen that, in order to produce a 10ft. disc with a 6in. objective, the lantern must be placed 20ft. from the screen.

On the other hand, we may possess several lenses of different foci, and it is necessary that the screen and the lantern must occupy certain positions, which we will suppose to be just 20ft. apart, and that the diameter of the disc must be 10ft. How are we to ascertain whether we must use a lens of 4, 5, 6, 7, or other number of inches in focus?

Multiply the distance between the lantern and the screen (D) by the size of opening of slide (B), and divide by the size of disc (C).

$$\frac{D \times B}{C} = A \text{ focus of lens} = \frac{20 \times 3}{10} = 6\text{in. focus.}$$

Again, we have a lens of 6in. focus, and intend that 20ft. shall intervene between the lantern and the screen, and wish to know what size of disc can be produced. In order to calculate this, it is necessary that we multiply the distance between the lantern and the screen (D) by the size of slide opening (B), and divide by the focus of the lens used (A), which gives us

$$\frac{D \times B}{A} = C \text{ size disc} = \frac{20 \times 3}{6} = 10\text{ft. dia. disc}$$

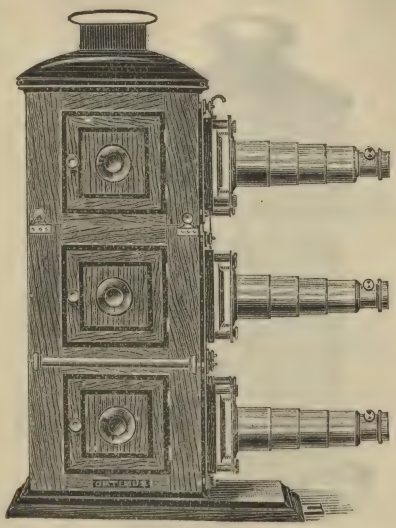
The following ready reference table has been computed by the foregoing rule, and by a glance it will show the relations between lantern and disc with object glasses of every focus from 4in. to 15in.

READY REFERENCE TABLE.

Distance between Lantern and Screen.	FOCUS OF LENS. 4in.		5in.		6in.		7in.		8in.		9in.	
	DIAMETER OF DISC.											
	ft.	in.	ft.	in.	ft.	in.	ft.	in.	ft.	in.	ft.	in.
10 feet.	7	6	6	0	5	0	4	3	3	9	3	4
11 ,,	8	3	6	7	5	6	4	9	4	2	3	8
12 ,,	9	0	7	2	6	0	5	2	4	6	4	0
13 ,,	9	9	7	10	6	6	5	7	4	11	4	4
14 ,,	10	6	8	5	7	0	6	0	5	3	4	8
15 ,,	11	3	9	0	7	6	6	5	5	8	5	0
20 ,,	15	0	12	0	10	0	8	7	7	6	6	8
25 ,,	18	9	15	0	12	6	10	9	9	4	8	4
30 ,,	22	6	18	0	15	0	12	10	11	3	10	0
35 ,,	26	3	21	0	17	6	15	0	13	1	11	8
40 ,,	30	0	24	0	20	0	17	2	15	0	13	4
45 ,,	33	9	27	0	22	6	19	3	16	10	15	0
50 ,,	37	6	30	0	25	0	21	5	18	9	16	8

Distance between Lantern and Screen.	FOCUS OF LENS. 10in.		11in.		12in.		13in.		14in.		15in.	
	DIAMETER OF DISC.											
	ft.	in.	ft.	in.	ft.	in.	ft.	in.	ft.	in.	ft.	in.
10 feet.	3	0	2	9	2	6	2	4	2	2	2	0
11 ,,	3	4	3	0	2	9	2	6	2	4	2	2
12 ,,	3	7	3	3	3	0	2	9	2	7	2	5
13 ,,	3	11	3	7	3	3	3	0	2	9	2	7
14 ,,	4	2	3	10	3	7	3	3	3	0	2	9
15 ,,	4	6	4	1	3	9	3	6	3	3	3	0
20 ,,	6	0	5	6	5	0	4	7	4	3	4	0
25 ,,	7	6	6	10	6	3	5	9	5	4	5	0
30 ,,	9	0	8	2	7	6	6	11	6	5	6	0
35 ,,	10	6	9	6	8	9	8	1	7	6	7	0
40 ,,	12	0	10	10	10	0	9	2	8	6	8	0
45 ,,	13	6	12	3	11	3	10	4	9	8	9	0
50 ,,	15	0	13	8	12	6	11	6	10	9	10	0

EXAMPLES.—An 8in. focus lens at a distance of 35ft. will give a disc of 13ft. 1in. To produce a disc of 12ft. with a lens of 10in. focus, the lantern and screen must be separated by 40ft. To produce a disc of 15ft. at a distance of 45ft. will require a lens of 9in. focus.



'OPTIMUS'

TRIPLE OXY-HYDROGEN LANTERN

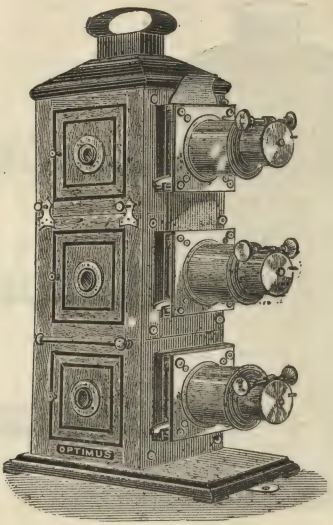
The Top of the Lantern may be used separately with Oil Lamp.

Seasoned Mahogany Body, 6 Panelled Doors with Sight Holes. Moulded foot, picked out with black, Highly Finished Brass Stages and Sliding Tubes, Achromatic Photographic Combination Front Lenses, (large diameter Back Lens,) Compound Condensers 4 inches diameter			
With 3-draw Telescopic Front Tubes, and SIX Photographic Front Lenses of 6-in. and 10-in. focus	22	18	0
3 Safety Gas Jets	1	13	0
'OPTIMUS' Triple Dissolving Tap (Patent)	1	13	0
	£26	4	0

The Draw Tubes are specially rigid, so maintaining the Optical Axis accurately, and ensuing the Front Lens, Condenser, and Slide occupying Parallel Planes.

Lantern Photographs, Plain, 12/-; Coloured, 18/6 per doz.

FOR THE TRADE. DISCOUNTS ON APPLICATION.



'OPTIMUS'

OXY-HYDROGEN TRIPLE LANTERN.

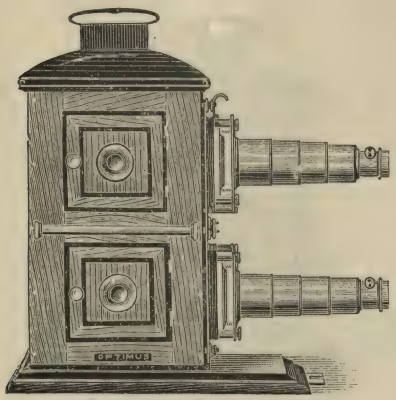
The Top Lantern may be used separately with Oil Lamp.

Seasoned Mahogany body, 6 Panelled Doors with Sight holes. Moulded foot, picked out with black, Finished Brass Stages and Sliding Tubes, Achromatic Photographic Combination Front Lenses, large diameter Back Lens, Compound Condensers of 4 inches diameter	**14**	**10**	**0**
3 Safety Gas Jets	**1**	**13**	**0**
'OPTIMUS' Triple Dissolving Tap (Patent)	**1**	**13**	**0**
Complete	**£17**	**16**	**0**

The Draw Tubes are made specially rigid, so maintaining the optical axis accurately and ensuring the front lens, condenser and slide occupying parallel planes.

Lantern Photographs, Plain, 12/-; Coloured, 18/6 per doz.

FOR THE TRADE. DISCOUNTS ON APPLICATION.



'OPTIMUS' BI-UNIAL OXY-HYDROGEN LANTERN.

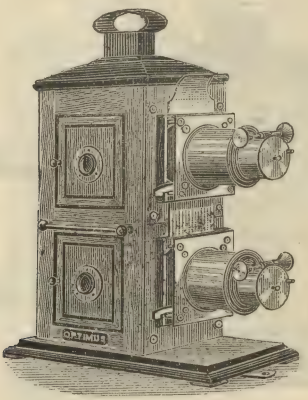
The Top Lantern may be worked separately, with our Mineral Refulgent Oil Lamp.

Seasoned Mahogany Body, 4 Panelled Doors with Sight Holes, Moulded Foot picked out with Black, Achromatic Photographic Combination Front Lenses, with large diameter Back Lens, Compound Bi-convex Condensers of 4 inches diameter	
Highly Finished Brass Stages, and with Brass 3-draw Telescopic Front Tubes, and FOUR Photographic Front Lenses of 6 inches, 8 inches focus	£14 14s.
2 Safety Jets	£1 2s.
6 Way Dissolving Tap	17s.
	£16 13s.

The Draw Tubes are specially rigid, so maintaining the Optical Axis accurately, and ensuring the Front Lens, Condenser, and Slide occupying Parallel Planes.

Lantern Photographs, Plain, 12/-; Coloured, 18/6 per doz.

FOR THE TRADE. DISCOUNTS ON APPLICATION.



'OPTIMUS' BI-UNIAL LANTERN

For Oxy-Hydrogen Lime Light.

The Top Lantern may be used with Oil Lamp.

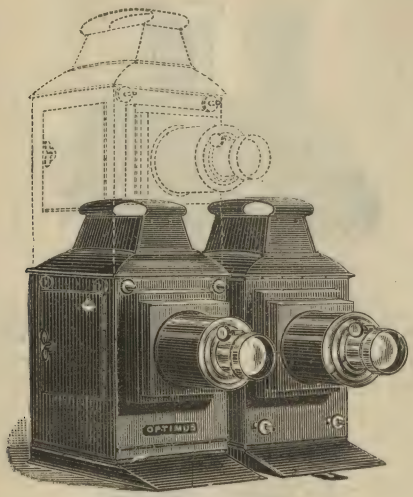
Seasoned Mahogany Body, 4 Panelled Doors with Sight Holes, moulded foot picked out with black, Japanned stages and tubes, Achromatic Photographic Front Lenses, compound condensers of 4 inches diameter **£5 12 0**

Ditto ditto with highly finished BRASS stages and sliding tubes... **8 8 0**

The Draw Tubes are specially rigid, so maintaining the Optical Axis accurately and ensuring the Front Lens, Condenser, and Slide occupying Parallel Planes.

Lantern Photographs, Plain, 12/-; Coloured, 18/6 per doz.

FOR THE TRADE. DISCOUNTS ON APPLICATION.



'OPTIMUS' SIDE-BY-SIDE OR BI-UNIAL MAGIC LANTERN.

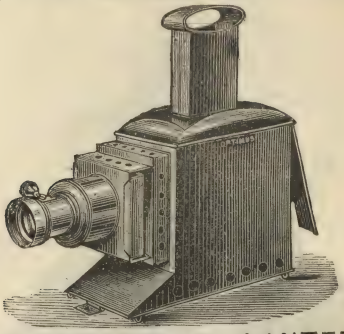
May be used as a pair with Oil or Lime-light.

The above Diagram represents a full-sized combined Lantern. It is made of japanned metal. It may be worked one above the other, as the dotted lines show, or side by side as the positive diagram shows: or again, the two Instruments may be separated and worked in two distinct places, as each Lantern is complete in itself. A further advantage is possessed by these Lanterns, for the body which is constructed to accommodate limelight will also readily accommodate oil lamps, the groove into which the trays are inserted being made to the same guage as our Lamps.

Without Lamps or Jets **£4 16 0**
Gas Jets ... ... each... **11 0**
3-Wick Lamps, each **12 0**

Achromatic Photographic Combination Front Lenses (with large diameter Back Lens). Compound Condensers of 4 inches diameter.

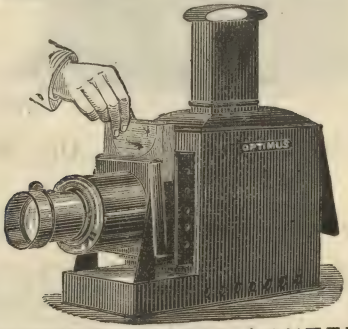
Lantern Photographs, Plain, 12/-; Coloured, 18/6 per doz.



'OPTIMUS' MAGIC LANTERN.

Japanned Metal Body **30/-**

Adapted for use with Limelight. For Dissolving 2 Lanterns are necessary.



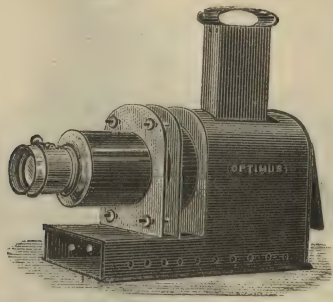
STUDENT'S MAGIC LANTERN.

Students' Lantern Japanned Metal Body (to take demonstrating tank) with finished Brass Sliding Tubes **40/-**

Do. Russian Iron Body, with finished brass front stage plate and sliding tube **55/-**

Adapted for use with Limelight. For Dissolving, 2 Lanterns are necessary.

Each Magic Lantern is efficient for exhibitions. The Lens gives crisp definition, being a superior Achromatic Photographic Combination (large diameter back lens), with rack and pinion. It is fitted to a telescopic lengthening tube, so gaining increased focal accommodation. The Condenser is composed of two plano-convex lenses of 4 inches diameter. The refulgent lamp has 3 wicks, or 4 wicks 2s. extra, yielding a brilliantly illuminated picture.—Each is complete in box.

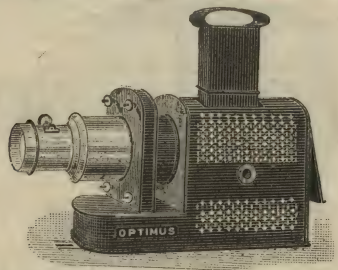


RUSSIAN IRON MAGIC LANTERN.

Highly Finished Brass Sliding Tubes ... . **45s.**

Adapted for use with Limelight. For Dissolving, 2 Lanterns are necessary.

Each Magic Lantern is efficient for exhibitions. The Lens gives crisp definition, being a superior Achromatic Photographic Combination (large diameter back lens), with rack and pinion. It is fitted to a telescopic lengthening tube, so gaining increased focal accommodation. The Condenser is composed of two plano-convex lenses of 4 inches diameter. The refulgent lamp has 3 wicks, or 4 wicks 2s. extra, yielding a brilliantly illuminated picture.—Each is complete in box.

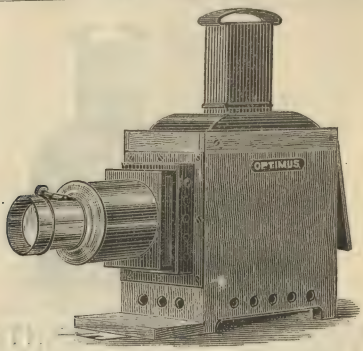


"OPTIMUS" MAGIC LANTERNS.

Perforated Russian Iron Body, Brass Sliding Tubes ... 50s.

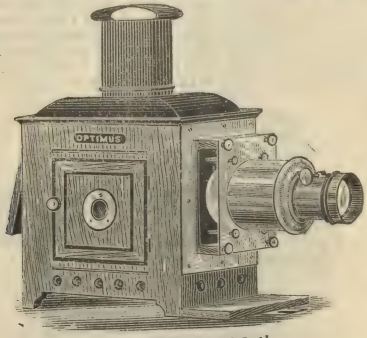
Adapted for use with Limelight. For Dissolving 2 Lanterns are necessary.

Each Magic Lantern is efficient for exhibitions. The Lens gives crisp definition, being a superior Achromatic Photographic Combination (large diameter back lens), with rack and pinion. It is fitted to a telescopic lengthening tube, so gaining increased focal accommodation. The Condenser is composed of two plano-convex lenses of 4 inches diameter. The refulgent lamp has 3 wicks, or 4 wicks 2s. extra, yielding a brilliantly illuminated picture.—Each is complete in box.



"OPTIMUS" MAHOGANY MAGIC LANTERN.

Mahogany outside Body, Japanned Metal Stages and Sliding Tubes ... **42s.**

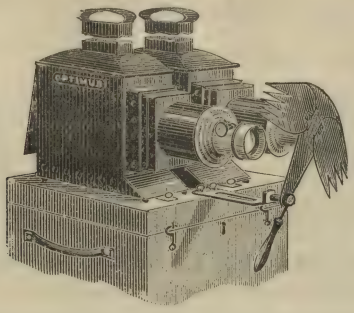


"OPTIMUS" SUPERIOR MAHOGANY MAGIC LANTERN.

Seasoned Mahogany Body, 2 Panelled Doors, Highly Finished Brass Stages and Sliding Tubes ... ... **82s.**

Adapted for use with Limelight. For Dissolving, 2 Lanterns are necessary.

Each Magic Lantern is efficient for exhibitions. The Lens gives crisp definition, being a superior Achromatic Photographic Combination (large diameter back lens), with rack and pinion. It is fitted to a telescopic lengthening tube, so gaining increased focal accommodation. The Condenser is composed of two plano-convex lenses of 4 inches diameter. The refulgent lamp has 3 wicks, or 4 wicks 2s. extra, yielding a brilliantly illuminated picture.—Each is complete in box.



'OPTIMUS'
PAIRS OF LANTERNS FOR DISSOLVING.

For Dissolving Views, two Lanterns are required, and are arranged in one portable box; either of the before mentioned styles of Lanterns may be selected. The extra cost above that of the two lanterns being 8/9, the price of the fan dissolver; if used for oxy-hydrogen light two gas jets are needed.

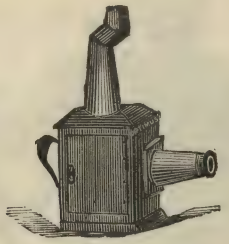
Japanned Metal Body	30/- each.
,, ,, Student's Form	40/- ,,
Mahogany Body, Lined with Metal	42/- ,,
Russian Iron Body	45/- ,,
,, ,, Perforated	50/- ,,
,, ,, Student	55/- ,,
Seasoned Mahogany Body, 2 Panelled Doors, all Brass Fittings ...	82/- ,,

Each Magic Lantern is efficient for exhibitions. The Lens gives crisp definition, being a superior Achromatic Photographic Combination (large diameter back lens), with rack and pinion. It is fitted to a telescopic lengthening tube, so gaining increased focal accommodation. The Condenser is composed of two plano-convex lenses 4 inches diameter. The refulgent lamp has 3 wicks (or 4 wicks, 2s. extra), yielding a brilliantly illuminated picture.—Each is complete in box.

Safety Blow through Gas Jets	11/- each.
Chamber (mixed) ,, ,, ...	16/6 ,,

Lantern Photographs, Plain, 12/-; Coloured, 18/6 per doz.

FOR THE TRADE. DISCOUNTS ON APPLICATION.



'OPTIMUS' MAGIC LANTERNS FOR YOUTHS.

To burn Paraffin or Mineral Oil.

The body of these lanterns is so constructed that the oil reservoir is not likely to become heated, since it falls through the bottom of the illuminated chamber and is in outside air.

Small Magic Lanterns, with condensers, front lens (adjustable), black japanned body, chimney, lamp and reflector—

No. 1 ... diam. front lens	$1\frac{1}{8}$ ... condenser	$1\frac{2}{3}$	...	2/6	each
2 ... "	$1\frac{1}{4}$ ... "	$1\frac{3}{4}$	...	3/10	"
3 ... "	$1\frac{5}{16}$ ... "	$2\frac{1}{16}$	...	6/6	"
4 ... "	$1\frac{1}{2}$ ... "	$2\frac{5}{8}$	...	9/-	"
5 ... "	$1\frac{1}{2}$ ... "	3	...	11/-	"
6 (in box) "	$1\frac{5}{8}$ ... "	$3\frac{1}{2}$	...	20/-	"

Boxes of 12 Slides for Lantern, each Slide containing several figures, arranged as Tales if desired.

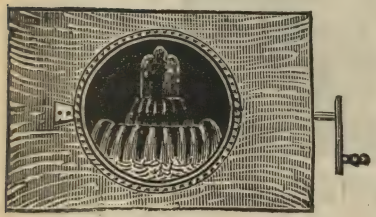
No. 1	Paper edge	3/- each.
2	"	3/8
3	Wood edge	6/8
4	"	9/4
5	"	12/-
6	"	16/-
7	"	18/8

NOTE.—We maintain the sizes, both of Lanterns and Slides, as of old: many makers call our No. 2 No. 3, and so on.

FOR THE TRADE. DISCOUNTS ON APPLICATION.

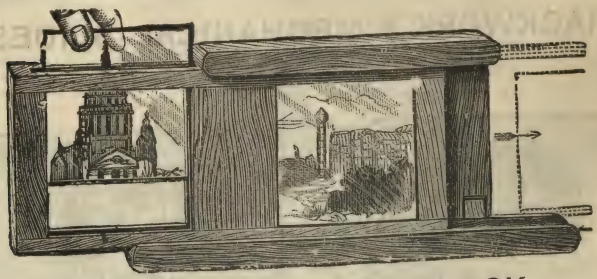
RACKWORK & MECHANICAL SLIDES.

For Lanterns with 4 inch Compound Condensers only.



	s.	d.	
CHROMATROPES, 3 inch diameter, best quality (various designs)	9	0	each
CHROMATROPES, 3 inch diameter, with Photographic Portraits, Mottoes, Views, &c. in centre	10	0	,,
CHROMATROPE CARRIER FRAME, with 6 Pairs of Painted Discs in rack box	21	0	,,
RACKWORK SOLDIERS' HEADS, changing to Donkeys' Heads	8	6	,,
SNOWSTORM EFFECT	7	0	,,
CURTAIN to roll up, showing Painted Curtain or Drop Scene ...	10	0	,,
DANCING SKELETON SLIDE, with lever motion taking off Head	9	0	,,
LIGHTNING EFFECT	1	9	,,
RAINBOW EFFECT	1	9	,,
LEVER MOON-RISING EFFECT	4	6	,,
MAN SWALLOWING RATS, rack mills, &c.	10	0	,,
RACK WORK, best painted wave slides	15	0	,,

FOR THE TRADE. DISCOUNTS ON APPLICATION.



SLIDING CARRIER BLOCK.

	s.	d.
For two pictures, per doz.	27	0
SETS OF EFFECT SLIDES for dissolving views from... per set	4	6
Sets of all the most popular Nursery Tales, in great variety best painted ... ... per slide...	4	0
Second quality ... ... per slide...	2	8
LONG PANORAMA SLIDES ... ... from...each...	2	3
Motto Slides ... ... ,, ,, ...	3	0
SETS OF 10 SLIDES, best rack astronomy, 2½ inch circles, in mahogany box	100	0
Ditto ditto in 3-inch ,, ,,	110	0
PHOTOGRAPHIC VIEWS taken in all countries per dozen	12	0
Colored ditto ... ... from per dozen	18	6
SQUARE WOOD BLOCKS, per gross	42	0
Soft limes, per tin of one dozen	1	0
Hard limes	1	6
Front lenses for lantern, rack motion, double achromatic photographic combination...	15	0
Ditto ditto long focus	26	0

Gas Jets.

Blow Through...	11/-
Chamber...	16/6
Interchangeable	18/9

Gas Bags, Gas Cylinders.

At lowest market prices.

Microscopic Front Lenses.

With Two Powers ... . 1t /-

Aphengescopes.

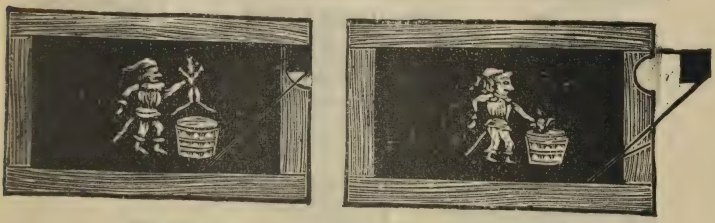
For exhibiting opaque objects, Cartes-de-Visite, &c. 16/-

Magic Lantern Slides.

Mechanical—viz., Chromotropes, Levers, Comic Slipping Slides, Sets of Effects, Sets of Tales, Photographs (coloured or uncoloured).

Magic Lantern Slides in Great Variety.

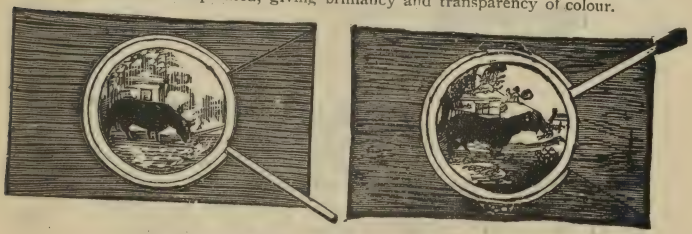
FOR THE TRADE. DISCOUNTS ON APPLICATION.



COMIC SLIPPING SLIDES.

600 Different Subjects ... ... per doz. **12/-**

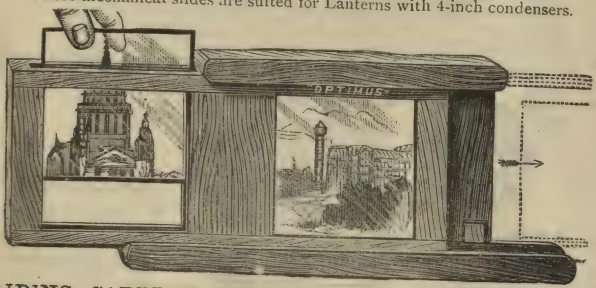
These are well painted, giving brilliancy and transparency of colour.



COMIC LEVER SLIDES.

300 Different Subjects ... ... per doz. **37/6**

These mechanical slides are suited for Lanterns with 4-inch condensers.

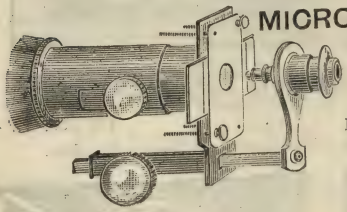


SLIDING CARRIER BLOCK, for two pictures, per doz. ... **17/9**

FOR THE TRADE, DISCOUNTS ON APPLICATION.

MICROSCOPE FOR LANTERN.

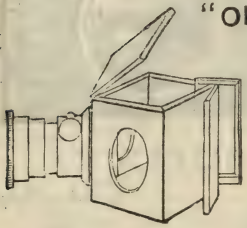
Having brass body with high and low powers, suitable for optical lantern possessing 4in. compound condensers **18/6**



MICROSCOPE FOR LANTERN.

(SUPERIOR.)

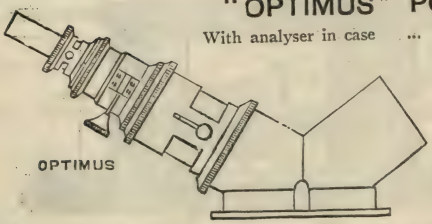
If with rack motion and revolving stage **84/-**



"OPTIMUS" APHENGESCOPE.

An instrument for exhibiting opaque objects, cartes-de-visite, etc. ; suitable for optical lantern with 4in. compound condensers **12/-**

Superior Aphengescope, arranged for pairs of lanterns with achromatic front lenses and rack adjustments **30/-**



"OPTIMUS" POLARISCOPE.

With analyser in case **195/-**

"OPTIMUS"

KALEIDOSCOPE.

In case with lock and key **35/-**

A cheap form of Kaleidoscope arranged as a slide **5/6**

REFULGENT LAMPS.

Stout Russian Iron. Burning Mineral Oil.

Two wicks	(wicks 1½ inches wide)	10/-
Three wicks		11/-
Four wicks		13/-
Two wicks	(wicks 2 inches wide)	12/6
Three wicks		13/6
Four wicks		15/6

LAMP WICK TRIMMER (Patent).

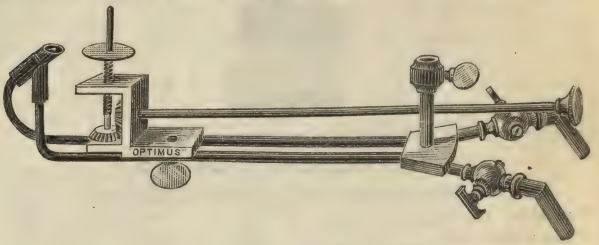
For 1½ inch wicks	2/6
For 2 inch wicks ..	4/9

This little contrivance saves much trouble. With one cut it cleans off the charred portion of wick, and leaves a perfectly even ridge of cotton to hold the flame, which, in consequence, burns with a clearness and freedom from smoke that is very desirable. It is particularly recommended for photographic developing lamps, and for lamps used with the optical lantern.—*British Journal of Photography.*

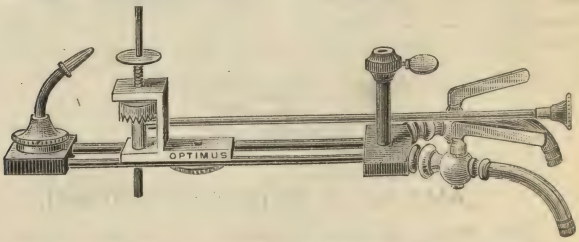
ANIMALCULÆ OR CHEMICAL TANK.

These being made of Glass and Indiarubber, are not affected by chemicals **3/6**

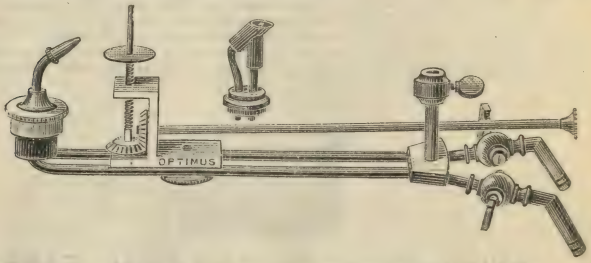
MAGIC LANTERN GAS JETS FOR LIMELIGHT.



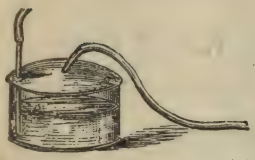
Best quality blow-through gas jet, with cog-wheel arrangement for turning, also raising and lowering the lime; platina nipple ... ... each **11/-**



Best mixed chamber gas jet, with cog-wheel arrangement for turning, also raising and lowering the lime; platina nipple ... ... each **16/6**

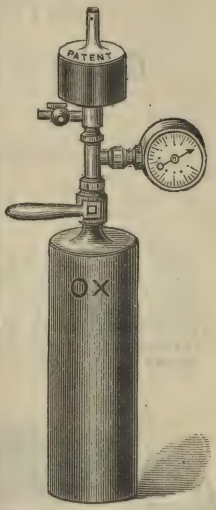


New interchangeable jet or both gases under pressure, mixed, or for blow-through form, by simply removing and using the burner as required; both have platina nipples ... ... each **18/9**



ZINC PURIFIER, 4/-

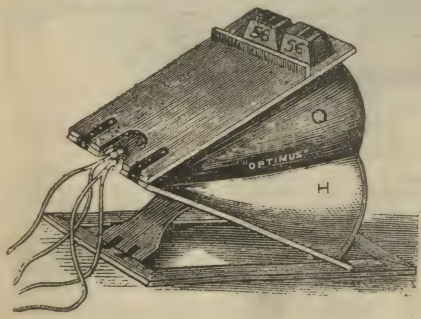
BRAZED IRON RETORT, 10/-



GAS CYLINDER

With Regulator and Pressure Gauge attached.

GAS BAGS—Stout Twill.



Subject to Fluctuations.

SIZES.		Capacity	Price
in.	in.	in. cubic ft.	
30 by	24 by	20 .. 4 ..	32/-
36	24	20 .. 5 ..	37/6
36	24	24 .. 6 ..	39/6
36	28	24 .. 7 ..	42/-
36	32	24 .. 8 ..	45/-
36	36	24 .. 9 ..	46/6
40	32	24 .. 9 ..	48/6
40	36	24 .. 10 ..	51/-
40	36	26 .. 11 ..	53/-
40	36	28 .. 12 ..	55/-

PATENT SAFETY POROUS

ETHER SATURATOR,

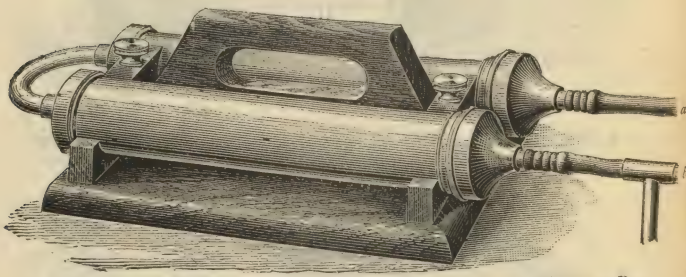
FOR PRODUCING THE

ETHO-OXYGEN LIME LIGHT,

FOR OPTICAL LANTERNS.

This Apparatus is the **most perfect** means for producing the Etho-Oxygen Lime Light, and gives the most powerful illumination known for Optical Lanterns. In its use there is no heat, no bubbling, and no obstruction to the free passage of the Oxygen. It can be disturbed or upset without affecting the light or spilling any Ether into the tubing. After one adjustment of the light, it will automatically regulate the supply of Ether vapour to correspond to any variation in the supply of Oxygen. **This is a very important advantage possessed by no other Apparatus.**

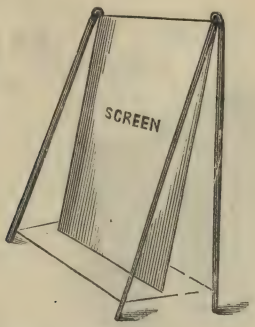
ILLUSTRATION.



a To Ether side of Jet. *b* To Oxygen side of Jet. T Piece—to Bag

It consists of two brass tubes or bodies, screwed into a bent brass connecting tube, lying side by side on an ebonised wooden stand, which is fitted with a handle for carrying about. The brass tubes or bodies can easily be removed by unscrewing the set screws which fasten them to the board. Each tube is fitted at one end with screw-down cap, having a nozzle in its centre for the purpose of attaching elastic tubing, and both are fitted with a roll of flannel or coarse cloth, having a spiral wire in the centre to keep them open. Each nozzle has a small screw cap to prevent escape of Ether when not in use.

PRICE 36/-



TRANSPARENT SCREENS. Best Union Cloth.

Feet square	5	6	7	10	12	14	16	20
	5/6	7/-	8/6	15/0	25/-	36/-	48/-	62/-

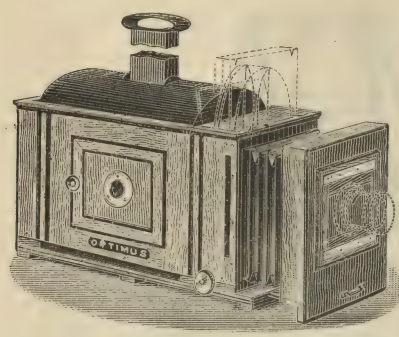
PORTABLE STANDS FOR SCREENS.

5	6	7	10	12	15	16	20 ft.
15/-	15/-	15/-	21/-	40/-	44/-	47/-	65/-

"OPTIMUS" (LECTURER'S) PORTABLE READING LAMP.

Price of Lamp, with Signal, Bell, and Match Box complete ... ... 8/- each.

FOR THE TRADE. DISCOUNTS ON APPLICATION,



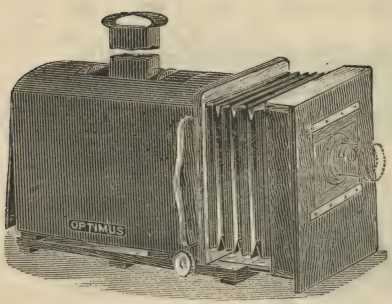
"OPTIMUS"

ENLARGING APPARATUS.

This Apparatus comprises superior Mahogany Body Lantern and long Bellows Camera adjusted by Patent Quick Action Rack and Pinion. The Lantern is fitted with powerful Refulgent Lamp, with 3 wicks, giving brilliant illumination. Compound Condensers.

CONDENSER.

5-inch	no front lens ...	100/-
5 ,,	with ,, ...	127/-
6 ,,	no ,, ...	133/-
6 ,,	with ,, ...	151/-
7 ,,	no ,, ...	155/-
7 ,,	with ,, ...	173/6
8 ,,	with ,, ...	256/-
9 ,,	with ,, ...	290/-
10 ,,	with ,, ...	360/-
12 ,,	with ,, ...	580/-



If with Russian Iron instead of Mahogany Body.

5-inch	no lens ...	75/-
5 ,,	and ,, ...	102/6
6 ,,	no ,, ...	87/6
6 ,,	and ,, ...	115/3
7 ,,	no ,, ...	110/-
7 ,,	and ,, ...	137/9
8 ,,	no ,, ...	160/-
9		210/-
10 ,,	,, ,, ...	285/-
12 ,,	,, ,, ..	450/-

Adapted for use with Lime-light or Oil Lamp.

When large sized Condensers are employed, it will be found advantageous to use the Oxy-hydrogen or Oxy-calcium Lime Light Burners; but good results are obtained with the Refulgent Mineral Oil Lamps supplied with the apparatus.

'OPTIMUS'

COMPOUND CONDENSERS (mounted) FOR ENLARGEMENTS.

Inches Diameter	3½	4	4½	5	6	7	8	9	10	12
	8/-	8/6	15/6	24/-	39/-	50/9	69/6	93/6	132/-	222/-

FOR THE TRADE. DISCOUNTS ON APPLICATION.

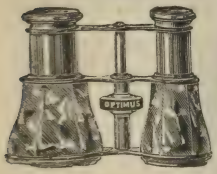
'OPTIMUS' DWARF OPERA,

Leather Covered,

15/-

'OPTIMUS' PEARL OPERA,

25/-



'OPTIMUS' ALUMINIUM OPERA.

50/-

'OPTIMUS' ECONOMIC FIELD GLASS.

Small Size .....
Clear Definition.....
Good Field of View
Magnifying 16 times

21/-

'OPTIMUS' SCORER.

Is unrivalled for excellence and cheapness. It shows the number of people in boats four miles distant, Sea-birds one mile distant, and Bullet-marks on Target at 600 yards.
Magnifying 25 times.

30/-

'OPTIMUS' SCOUT.

Medium Size.....
Clear Definition .....
Good Field .....
High Magnifying Power (64 times).

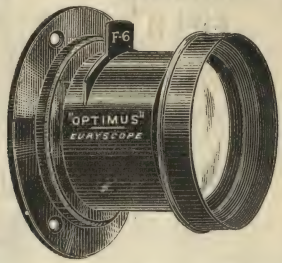
70/-

For General Excellence, Definition, and Magnifying Power, we invite intending Purchasers to test our Field and Opera Glasses against any in the world.

Opera Glasses in Great Variety.

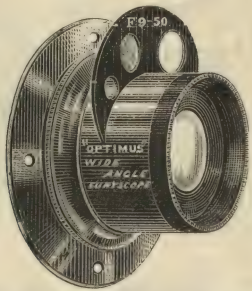
FOR THE TRADE. DISCOUNTS ON APPLICATION.

'OPTIMUS'
RAPID PHOTOGRAPHIC LENSES.



Extra Rapid Euryscope, large Diameter (Double). The aperture is **F/6.** The Lenses are of special optical glass, constructed with the nicest precision of curvatures, so maintaining good marginal definition, coupled with the most **Extreme Rapidity.**

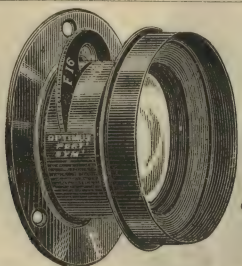
To cover	5 by 4	7 by 5	8 by 5	9 by 7	10 by 8
Equiv. Focus	5½	8¾	10	12	14 inches.
	63/-	**94/6**	**110/-**	**126/-**	**220/-**



Wide Angle Euryscope (Double), F/9·50. This aperture is exceedingly open for wide angle work. The definition, however, is in no way sacrificed, as the curvatures are perfectly accurate, and the most minute detail in architectural and interior subjects is rendered with the maximum of crispness, and a total absence of distortion.

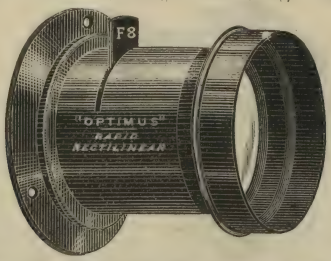
To cover ...	5 by 4	7 by 5	9 by 7	10 by 8
Equiv. Focus ...	3¼	4¾	6	8 inches.
	63/-	**94/6**	**126/-**	**220/-**

FOR THE TRADE. DISCOUNTS ON APPLICATION.



Portable Symmetrical (Double), F/16 with revolving diaphragms. Specially adapted for Architecture, being of short focus and wide angular aperture, can be used to advantage when very close to the subject. It is also useful for landscapes, as well as copying. The smaller sizes give beautiful **Lantern Slides**, the definition being exceptionally crisp.

To cover	$\frac{5}{4}$	$\frac{7}{5}$	$\frac{9}{7}$	$\frac{10}{8}$	$\frac{12}{10}$	$\frac{15}{12}$	$\frac{18}{16}$	plates.
	39/-	52/6	82/6	127/6	142/6	180/-	225/-	

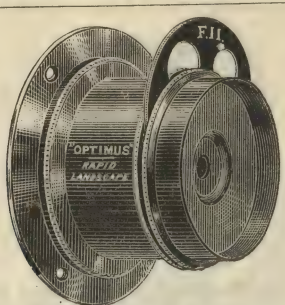


Rapid Rectilinear (Double) F/8.—Second only to the Euryscope for Rapidity therefore well suited for instantaneous effects, outdoor groups and views, as well as interiors. Copying and enlarging are also within the capabilities of the lens; in fact its work may be styled "**UNIVERSAL.**"

To Cover	$\frac{5}{4}$	$\frac{6}{5}$	$\frac{7}{5}$	$\frac{8}{5}$	$\frac{9}{7}$	$\frac{10}{8}$	$\frac{12}{10}$	$\frac{15}{12}$	$\frac{18}{16}$	
Focus	$5\frac{1}{2}$	$6\frac{3}{4}$	$8\frac{8}{7}$	10	12	14	18	20	25	inches.
	33/-	**45/-**	**49/6**	**64/-**	**82/6**	**127/6**	**142/6**	**180/-**	**225/-**	

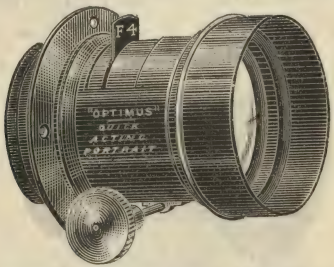
. . . . We may call attention to the extensive optical and metal works that Perken, Son and Rayment have established in Hatton Garden, and their photographic cabinet factory in Saffron Hill. At the former we were much interested in the glass-grinding departments—one for photographic lenses, another for spectacles; and we were surprised to find in London such extensive workshops for the metal parts of cameras and optical lanterns; indeed, we thought outside Birmingham we should not find such workshops in the United Kingdom.—*Photographic News.*

We are pleased to find upon trial that the Lens ["Optimus" Rapid Rectilinear] sent for review is really an excellent instrument.—*Photographic News.*



Rapid Landscape.—Works *f*/**11**, and gives brilliant negatives. Particularly suited for landscapes, also capable of being worked as a Portrait lens.

To cover...	5 by 4	7 by 5	9 by 7	10 by 8	12 by 10 plates.
Focus ..	5½	9	12	14	18 inches.
	25/-	**36/-**	**45/-**	**75/-**	**110/-**



Portrait Lens.—Specially constructed as quick acting for short exposures in Portraiture. They are second to none, the definition being maintained by their perfect optical qualities.

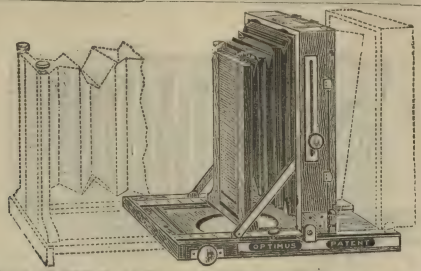
Diam.	2 inches.	2¾ inches.	3½ inches.	
Price	90/-	120/-	180/-	*Larger Sizes to order.*
	1 B.	**2 B.**	**3 B.**	

'DEAR SIRS,—Herewith your 7 x 5 "Optimus' Lens, which, as per your request, I have tried in the production of large heads. Along with it I send two negatives taken by it, the head in one of them measuring *two* inches, that in the other being *three* inches. In both, the perspective seems right enough, there being no appearance of its being strained or violent.

'With us, it was rather dark and very rainy all day, and I took the negatives inside a room, without a diaphragm, exposure 7 secs. and 10 secs. respectively. The SHARPNESS of all the planes of the head is good, as you will perceive. The distance of the sitter from the lens was 3 ft. 6½ ins. for the larger head, and 4 feet 9 in. for the smaller head.—Yours truly, J. TRAILL TAYLOR.'

'If E. G. E. wants the FINEST LENS in the market he cannot do better than get the "OPTIMUS."—Professor DE FRERE.'—*Amateur Photographer.*

FOR THE TRADE. DISCOUNTS ON APPLICATION.



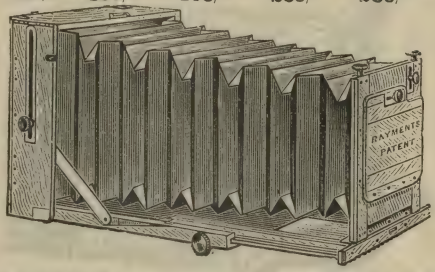
"OPTIMUS" WIDE ANGLE CAMERA. EXTRA LONG FOCUS.

Baseboard does not cut off the view when using wide angle lenses.

This Instrument possesses every possible advantage, being very Light, very Rigid, and very Portable. The focussing screen and body may be brought towards the front of Baseboard so as to prevent obstruction when using lenses of wide angular aperture and short focus. It is provided with double-swing arrangement and long-focussing (rack) adjustment. When closed the lens may remain attached to its proper position (the front), and project through the TURNTABLE Baseboard.

Price, including 3 Double Dark Slides—

4¼ by 3¼	5 by 4	6½ by 4¼	8½ by 6½	10 by 8	12 by 10	15 by 12
140/-	**146/-**	**165/-**	**188/-**	**235/-**	**283/-**	**350/-**



RAYMENT'S PATENT CAMERA. EXTRA LONG FOCUS.

"I should strongly recommend RAYMENT'S Camera. It is LIGHT, COMPACT, very RIGID, and extends to about double the usual focus."—*Amateur Photographer.*

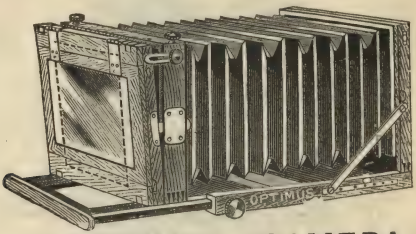
"The 'RAYMENT' Camera, in particular, claims attention, both for its BEAUTY of WORKMANSHIP and for the EASE and READINESS with which it can be put into action."—*The Camera.*

It can be set up almost instantaneously, has no loose parts, and includes all motions, having hinged focussing screen (adjusted by rack and pinion action), double swing back, cross fronts reversing back arrangement so that oblong dark slides give either horizontal or vertical pictures without unscrewing the Camera from the tripod.

Price of Camera, including 3 Double Dark Slides—

4¼ by 3¼	5 by 4	6½ by 4¼	8½ by 6½	10 by 8	12 by 10	15 by 12
120/-	**126/-**	**145/-**	**168/-**	**212/-**	**258/-**	**314/-**

FOR THE TRADE. DISCOUNTS ON APPLICATION.

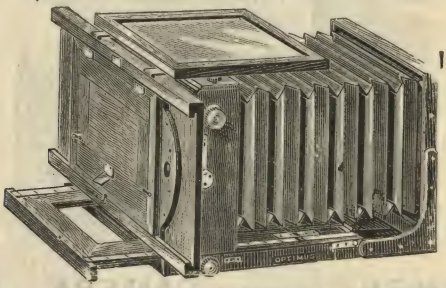


"OPTIMUS" CAMERA. LONG FOCUS.

The Instrument can be set up almost instantaneously, has no loose parts, and includes all motions, having hinged focussing screen (adjusted by rack and pinion action), double swing back, cross fronts reversing back arrangement so that oblong dark slides give either horizontal or vertical pictures without unscrewing the Camera from the tripod.

Price of Camera, including 3 Double Dark Slides—

4½ by 3¼	5 by 4	6½ by 4¾	8½ by 6½	10 by 8	12 by 10	15 by 12
130/-	**133/-**	**137/-**	**175/-**	**227/-**	**275/-**	**333/-**



"OPTIMUS" STUDIO CAMERA.

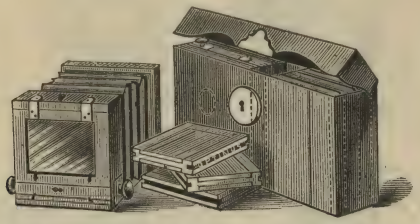
Specially arranged for Studio Use.

"Invited to say, if in our estimation, the Studio Cameras of Perken, Son, and Rayment could be improved in any way whatever, for the purpose for which they are intended, we must answer, No!" - *British Journal of Photography.*

This Camera is perfectly rigid, has double length of Bellows to suit small studios where large pictures are required, is fitted with Mechanical Adjustment to Focus, and swing back. It is in all respects a perfect Instrument.

Camera with repeating frame masks, and one single dark slide—

6½ by 6½	8½ by 8½	10 by 10	12 by 12	15 by 15
145/-	**188/-**	**225/-**	**265/-**	**325/-**



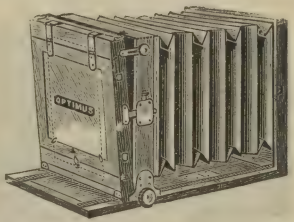
"OPTIMUS" PORTABLE FOLDING CAMERA.

Cheap, Strong, Serviceable, and Efficient.

Durable bellows, hinged focussing screen with sliding adjustment, readily and securely held in exact position by means of a pinion passing through the body nearest bottom or baseboard and having milled head screws on either side of the instrument to clamp tight.

Camera and one Double Dark Slide—

4¼ by 3¼	5 by 4	6½ by 4¾	8½ by 6½
21/-	24/-	39/6	48/-



PORTABLE (A.R.) CAMERA.

Compact, Rigid, Inexpensive, and of Excellent Finish.

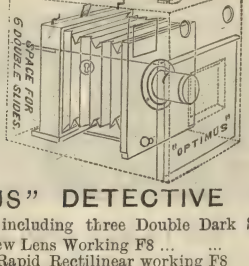
These Instruments have Leather Bellows, and are fitted with hinged Focussing Screen, adjusted by Rack and Pinion, Square Reversing Back, so that horizontal or vertical pictures may be taken without removing Camera from Stand.

Price of Camera, including 3 Double Dark Slides—

4¼ by 3¼	5 by 4	6½ by 4¾	8½ by 6½	10 by 8	12 by 10	15 by 12
85/-	87/6	98/-	125/-	150/-	200/-	260/-

Extra for Brass Binding Camera, and 3 Double Dark Slides—

25/-	28/-	30/-	32/-	33/-	38/-	48/-



"OPTIMUS" DETECTIVE CAMERA.

Price, including three Double Dark Slides.	£	s.	d.
With Optimus Rapid View Lens Working F8	5	10	0
Ditto, with "Optimus" Rapid Rectilinear working F8	6	6	0
Ditto, with "Optimus" Rapid Euryscope working F6	7	7	0
"Extra" Double Dark Slides each		8	6

The Shutter is arranged for exposures of any duration not less than $\frac{1}{100}$ of a second. The Shutter and Camera occupy so little space that six Double Dark-Slides, accommodating twelve Dry Plates, can be carried, in addition to a Focussing Screen. A panel slides up at the end of the box, displaying the screen for focussing. The exactness in focussing is simple, and the position is maintained by a secure clamping arrangement. A similar sliding panel is fitted to the front end, which completely hides the lens. The exterior is covered with leather, and measures 9¼ by 5½ by 7½. (Negatives 4¼ by 3¼ or 3¼ by 3¼.)

"OPTIMUS" MAGAZINE CAMERA.

NO DARK SLIDES REQUIRED.

	£	s.	d.
With Rapid Rectilinear Lens, working at F8	6	6	0
With Rapid Euryscope working at F6	7	7	0

Twelve dry plates are placed in the upper portion of the grooved travelling reservoir. The bases of these plates rest upon the top of the Camera body. The grooved reservoir recedes gradually from the Exposure Chamber when the pinion is revolved—allowing one plate at a time to fall to the bottom half of the reservoir, and so place its sensitized surface within the Exposure Chamber opposite to the Lens, and exactly in true focussing register. The rapidity and simplicity of working is unique. The twelve plates may, if desired, be exposed in as many seconds. There is no possibility of the plates sticking. The Shutter is suitable and convenient.

"OPTIMUS"

PORTABLE SETS OF PHOTOGRAPHIC APPARATUS.

Fitted COMPLETE in Cabinet, with Tripod Stand.

	£	s.	d.
Quarter Plate Size ($4\frac{1}{4}$ X $3\frac{1}{4}$) includes every requisite	1	16	0
Half Plate Size ($6\frac{1}{2}$ X $4\frac{3}{4}$)	3	10	0
Quarter Plate Size ($4\frac{1}{4}$ X $3\frac{1}{4}$) as diagram	2	5	0
Half Plate Size ($6\frac{1}{2}$ X $4\frac{3}{4}$)	5	0	0
Superior Camera, Rack and Pinion focussing adjustment,			
Quarter Plate ($4\frac{1}{4}$ X $3\frac{1}{4}$)	3	8	0
,, Half Plate ($6\frac{1}{2}$ X $4\frac{3}{4}$)	5	15	0
,, Whole Plate ($8\frac{1}{2}$ X $6\frac{1}{2}$)	9	10	0

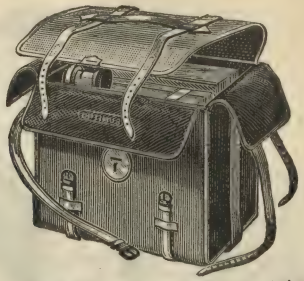
BRASS BINDING *any* CAMERA, and 3 Double Dark Slides--

$4\frac{1}{4}$ by $3\frac{1}{4}$	5 by 4	$6\frac{1}{2}$ by $4\frac{3}{4}$	$8\frac{1}{4}$ by $6\frac{1}{2}$	10 by 8	12 by 10	15 by 13
27 6	28 0	30 0	32 0	33 0	38 0	48 0

EXTRA DOUBLE DARK SLIDES for *any* of our Cameras--

	$4\frac{1}{4}$ by $3\frac{1}{4}$	5 by 4	$6\frac{1}{2}$ by $4\frac{3}{4}$	$8\frac{1}{4}$ by $6\frac{1}{2}$	10 by 8	12 by 10	15 by 12
Solid, no hinges— EACH	7/3	8/3	10/9	...	...	...	...
Solid, with hinged shutters EACH	10/3	10/9	11/9	...	...	...	...
Hinged opening and Hinged shutter each	14/-	14/6	15/-	21/6	25/6	31/6	47/3

FOR THE TRADE. DISCOUNTS ON APPLICATION.



CAMERA CASES, with Shoulder Straps,

LINED WITH GREEN CLOTH.

SQUARE— $\frac{1}{2}$, 20/-; $\frac{1}{1}$, 29/-; $\frac{10}{8}$, 35/-; $\frac{12}{10}$, 46/- Leather.
$\frac{1}{2}$, 15/9; $\frac{1}{1}$, 20/-; $\frac{10}{8}$, 21/6; $\frac{12}{10}$, 28/- Canvas.

OBLONG— $\frac{1}{4}$, 10/6; $\frac{1}{2}$, 12/6; $\frac{1}{1}$, 20/- Canvas only.

PORTABLE "UMBRELLA" RUBY TENT (PATENT.)

NON-ACTINIC.

Like an umbrella, it folds into a very small space, and can be set up for developing or changing plates as easily as its well-known prototype. Made of two thicknesses of material, one ruby, the other orange colour, no light can enter except it be filtered through these media. The head and hands are introduced so that the operator, sitting in his chair can conveniently watch the progress of his work whilst the tent rests on the table.—*Beginner's Guide to Photography.*

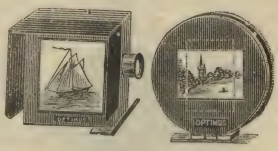
Made in two sizes—	Dimensions closed. Inches	Price s.	d.
For changing Plates	24 by 3	25	0
For Developing ,, ...	28½ by 3	35	0

WAISTCOAT DETECTIVE CAMERA.

THIS INSTRUMENT IS ONLY MADE BY THE PATENTEE,
C. P. STIRN.

With Plates for 36 Exposures 23/6
" 24 " Larger Size for Lantern Pictures ... 35/-

"OPTIMUS" VIEW FINDERS.



Camera Obscura Model ... ... each 5/-
1¼-inch bi-concave ... ... " 2/6
2½ " " ... ... " 6/-
3½ " " ... ... " 8/6

FOCUSSING GLASSES.

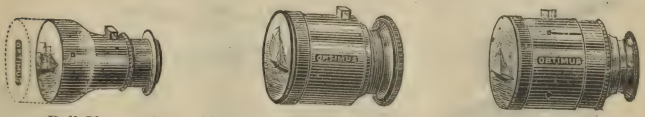
Per doz.—

9/9 15/9 18/3 33/9

With Archimedean Screw.

60/- per doz.

COMBINED FOCUSSING GLASS AND FINDER.



Bell Shape, 2/- each.

Screw Adjustment. 4/- each.

Sliding Adjustment. 5/- each.

PATENT

PERFECTION

PHOTOMETER.

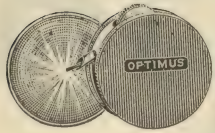
CORRECT EXPOSURE A CERTAINTY.

Each ... **6/9.**

"OPTIMUS"

MAGNESIUM

RIBBON LAMP, 5/-



British Journal of Photography, Nov. 7th, 1888 :—"It is a neat little thing, not greatly exceeding the dimensions of an old-fashioned watch, and projects a *powerful* beam of *light.*

HASTINGS'

FLASH LAMP.

1/3 With Mouthpiece. | With Pneumatic Ball **2/6**

"A handy Lamp. It is especially adapted for taking instantaneous photographs at night. The glass tube is charged with magnesium powder, and the brass trough filled with methylated spirit; this being lighted, the pneumatic ball is squeezed, the flash is given, and the photograph taken."—*Amateur Photographer.*

MAHOGANY

RETOUCHING DESKS.

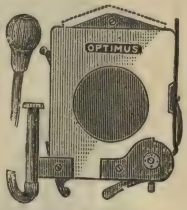
Whole-plate	16/8
12 x 10	25/-
15 x 12	35/6

Each has the smaller Carriers.

FOR THE TRADE. DISCOUNTS ON APPLICATION.

"OPTIMUS" PLUNGE SHUTTER (PATENT).

"Mr. J. Traill Taylor exhibited a pneumatic shutter, giving exposures of any duration, at will, and avoiding all vibration. He stated it was one of the best shutters he had seen, and said it was made by Perken, Son, and Rayment."—*British Journal of Photography.*



This may be styled the most **PORTABLE** of shutters. It is made either to fit on the hood, or may be adapted to act between the lenses of a doublet.

To fit ¼ or ½ plate Optimus Lens	30/	Complete with Pneumatic Release.
,, ¼ ,, ,, ,, ...	36/	
,, 10 x 8 ,, ,, ...	48/	

"OPTIMUS" BETWEEN LENS SHUTTERS.

Is arranged to fit the lens mount like a saddle. Exposure is effected by a plunger working between the two combinations of a double lens, or in front of them if preferred. Both pneumatic and hand releases are provided. Exposures varying from $\frac{1}{75}$ of a second to prolonged may be attained. The working parts are strong, and derangement impossible with a reasonably careful operator. Weight and bulk are reduced to a minimum.

Prices same as above.

PHANTOM SHUTTER, with Hand Release.

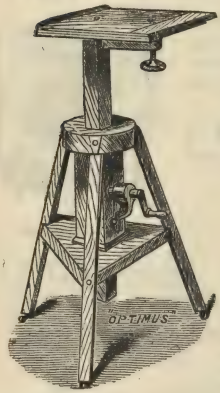
For Diameter of Front Lens.

Inch.	1½	1¾	2	2¼	2½	2¾	3	3¼	3½
	13/-	14/6	15/9	16/9	18/3	19/6	20/9	21/9	23/3

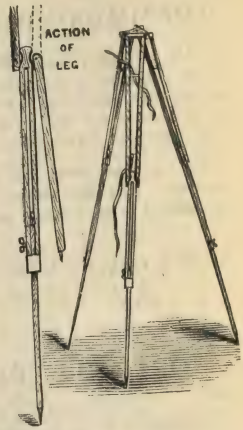
IF FITTED WITH PNEUMATIC RELEASE.

1½	1¾	2	2¼	2½	2¾	3	3¼	3½
20/9	22/-	23,3	24/6	25/9	27/-	28/3	29/6	30/9

FOR THE TRADE. DISCOUNTS ON APPLICATION.



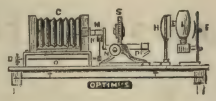
TRIPOD AND STUDIO.



"OPTIMUS" STANDS FOR CAMERAS.

	¼ s.	¼ d.	½ s.	½ d.	1/1 s.	1/1 d.	10/8 s.	10/8 d.
Telescopic, with sliding leg adjustment, rigid	8	6	9	6	10	9	16	9
Folding Ash, with Bayonet joint, "E.P.," very rigid	9	9	10	9	12	6	20	3
Telescopic Ash, with sliding leg adjustment, "Maudsley" pattern	18	6	19	9	20	9	24	9
Telescope Ash, 3-fold, as sketch			22	0	24	0	29	0
'OPTIMUS' Stand, very rigid and much recommended for large sizes			15	0	16	0	22	6
*4-FOLD, Very Portable			20	0	25	0	35	0
Pine Studio Stands with rack	14	6	30	0			43	9
Mahogany					45	0	78	9

* *Specially Portable. Strongly recommended where Small Bulk is important.*

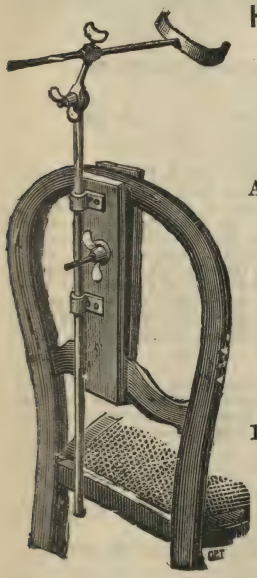


"OPTIMUS"

MICO-PHOTOGRAPHIC APPARATUS.

	£ s. d.
Camera, with Dark Slide, Microscope, 2-inch Objective, Lamp, Condenser, &c.	9 10 0
Superior Camera and Microscope, with Rack and Pinion Adjustment Fitted for Focussing as well as for Adjusting the Stage... ...	14 0 0

HEAD RESTS.



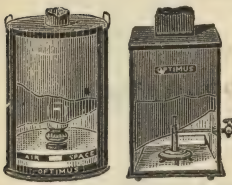
Amateur, to fit on Chair ... 7/6

STUDIO

15/- 28/- 42/-

FOR THE TRADE. DISCOUNTS ON APPLICATION.

"OPTIMUS" LAMPS FOR DARK ROOM.



The Lantern shown in the diagram is fitted with a gas jet adjustable from the outside: the light can thereby be readily lessened or increased at will. In front is a sheet of ruby or orange glass, easily removed, behind which is a double thickness of canary fabric set in a metal frame; it is, therefore, safe when developing the most sensitive of plates. As development progresses, one of the non-acting media can be moved, and the negative examined by the protection the second medium continues to give, enabling the amount of detail to be judged with certainty. In this lamp the joints are all perfectly light-tight, being made with a double turn over of tin; the upper parts are also held together with rivets. Ventilation is well considered, as a shaft at the back of the lamp, open at bottom and top, encourages a free circulation of air. Without doubt this lamp has no equal for the purpose for which it is intended.—*British Journal of Photography.*

Fitted either with Gas or Argand Burner for Paraffin Oil.

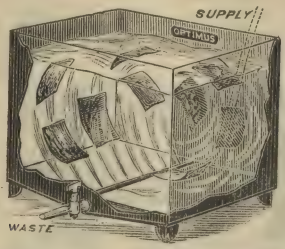
Square or Round ... ... each **13s.**

The form of Lantern shown in the accompanying diagram presents a great many advantages. It possesses a powerful Lamp so arranged that the oil receptacle is isolated from the flame and cannot get heated. Plenty of air circulates. In front is a sheet of ruby glass (removable), behind which is a sheet of deep orange; it is therefore safe when developing the most sensitive of Plates. As development progresses the ruby glass can be raised and the Negative examined by the orange glass only, enabling the amount of detail to be readily judged, per doz. **88/-**

FOLDING LAMP.—An inexpensive form of Lamp having two sides of metal, and the third of red glass. The metal sides are hinged together, so that they fold up for travelling, with the ruby glass protected from fracture by lying between them. Top and bottom triangular pieces—one forming a candle-holder and the other a chimney—complete this clever little arrangement ... ... per doz. **30/-**

REDDINGS' PATENT PORTABLE LAMP—
Small, **40/-**: Medium, **54/-**; and Large, **72/-** per doz.

CANDLES for above ... ... Small, **28/-**; Large ditto, **42/-** gross.

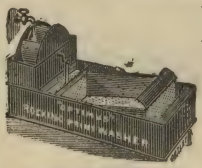


"OPTIMUS" REVOLVING PRINT-WASHER.

Water is injected from a perforated tube which crosses the tank at the bottom. The force of water creates a revolving current which carries the prints over and over in its course. The bottom is slightly V shaped and contains an outlet for waste.

Prices, including Grooved Metal Rack, which fits into the tank and accommodates negatives which can be also washed. Making the machine efficient for both NEGATIVES and PRINTS.

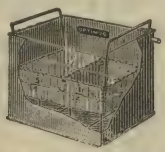
For Negatives and Smaller ... $\frac{1}{1}$, **16/-**; $\frac{10}{8}$, **21/-**; $\frac{12}{10}$, **30/-**



"OPTIMUS" ROCKING PRINT-WASHER.

Water running from a tap revolves the wheel which is connected with the cradle, causing it to rock up and down at each revolution. A syphon is fitted to drain the tank. One hour's washing is ample.

inches 9 × 7 cradle **18/6** | 11 × 9 cradle **28/-** | 13 × 11 cradle **32/-**
16 × 13 „ **39/6** | 20 × 16 „ **50/-**

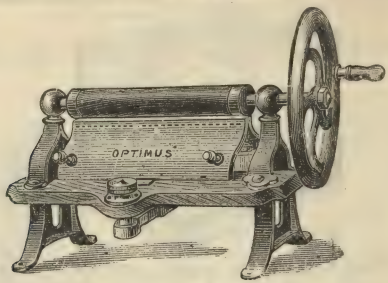


NEGATIVE WASHER

AND DRAINING RACK, COMBINED,

For Quarter, Five by Four, Half, and Whole Plate Negatives, **7/9**.

FOR THE TRADE. DISCOUNTS ON APPLICATION.

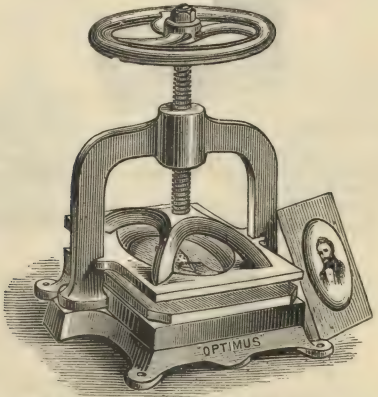


"OPTIMUS"

BURNISHERS FOR PHOTOGRAPHIC PRINTS.

The Burnishing Bar is specially hardened. The Frame is of superior and convenient construction. It is Nickel-plated, and of beautiful finish. Each instrument is mounted on a table with legs.

Plate	$\frac{1}{4}$	$\frac{1}{2}$	1	$1\frac{1}{8}$	$1\frac{3}{10}$	$1\frac{5}{12}$	(larger
Price	20/-	30/-	36/-	45/-	60/-	90/-	to order.)



"OPTIMUS" CAMEO PRESSES.

Carte de Visite (2 shapes) 10/-
Cabinet (3 shapes each for Cabinet and Carte de Visite) 22/-

PHOTOGRAPHIC SUNDRIES.

Vulcanite Trays.

	3 by 3½	4¾ by 3¾	5¾ by 4½	7 by 5¼	8 by 6	9 by 7	11½ by 9½	13½ by 11¼	1½
Price per doz.	5/3	5/9	6/9	8/9	15/-	19/-	27/-	46/-	

Porcelain Trays.

	5 by 4	6 by 5	7 by 5	8 by 6	9 by 7	10 by 8	11 by 9	12 by 10	13 by 11	14 by 11
Price per doz.	7/3	8/6	9/3	10/6	12/6	15/-	20/-	25/-	35/-	42/-

Papier Mache.

	4¾ by 3	7 by 5	8¾ by 6¾	10¾ by 8¼	12¼ by 10¼	15¼ by 12¼
Price per doz.	6/9	11/-	14/-	21/-	28/6	45/-

Folding Plate Racks.

For draining plates after washing: (to hold 12)

10/3 13/6 18/-

,, ,, (,, 24)

14/- 18/- 24/-

Graduated Glass Measures.

	1dr.	2dr.	1oz.	2oz.	4oz	6oz.	8oz.	10oz.	16oz.	20oz.	32oz.	40oz.
Per doz.	6/-	7/6	6/9	8/-	10/3	12/9	14/3	15/9	22/3	27/-	40/6	45/

Glass Funnels, Ribbed or Plain.

Diam. of Top	Ins. 1½	2	2	3	4	4½	5	5½	6	7	8
Price per doz.	3/-	3/3	3/6	4/0	4/6	5/-	7/-	9/-	12/-	16/-	21/-

Cutting Shapes.

	C.D.V.	4 by 3	Cabinet.	6½ by 4¾	8¼ by 6½	10 by 8	12 by 10
Price per doz.	5/6	6/-	9/6	10/6	22/-	36/-	48/-

PHOTOGRAPHIC SUNDRIES.

Printing Frames Oak.

Superior finish, round corners, brass springs, per doz.

4¼ by 3¼	5 by 4	6½ by 4¾	8½ by 6½	10 by 8	12 by 10
4/9	6/2	8/9	12/6	18/-	27/-

Mahogany, superior, per doz.

9/-	15/-	21/-	32/-	50/-	66/-

Light-tight Plate Boxes.

Mahogany, for 12 plates, per doz.

30/-	43/-	54/0	68/-	78/	84/-
" " 24 " "					
60/-	72/-	80/-	102/6	144/-	180/-

Negative Boxes.

White Wood (to hold 12), per doz.

10/6	12/-	18/-	22/6	37/6	45/-
" (" 24), "					
12/9	13/6	22/6	28/-	40/-	57/-
" (" 50), "					
16/6	21/-	28/6	39/-	57/-	66/-

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6/6	12/6	18/-	25/6	30/-	48/-

Carriers or Inner Frames.

For Double Dark Slides, to carry smaller plates, per doz.

15/9	18/-	21/-	27/-	36/-	48/-

SETS OF LANTERN PHOTOGRAPHS.

Price Uncoloured .. .. 12s. per dozen.
„ Coloured .. .. 18s. 6d. „

Number of Slides comprised in each Set is stated in figures attached to each Title.

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A Trap to Catch a Sunbeam ...	15
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A true Story of the old Coaching Days	10
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A Walk in the "Zoo"	48
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Adventures of Brown, Smith, Jones and Robinson	4
Æsop's Fables	50
Afghan War...	36
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Algiers	20
Alice in Wonderland	42
„ „ Songs ...	7
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Androcles and the Lion	6
Animal Sagacity	24
Animals at the Zoological Gardens	215
An Old Story	26
Art Collections, South Kensington Museum	59
Astronomy ... ... }	
Astronomical Instruments }	300

B

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„ „	17
Barred Window	8
Bashful Man...	6
Beautiful Snow	5
Belgium	50
Berlin...	46
Bible Manners and Customs ...	30
Blunderbore...	12
Book of Martyrs	52
Bookworm...	12

B (*continued*).

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Bottle, The	8
Boys and Ravens	8
Boys of Corinth	12
Brazilian Ape	14
Brighton Aquarium	14
Briggs and the Bull	78
British Museum, Antiquities of &c.	28
Brown and the Bear	12
Brown and Mouse	12
Brussels	50
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Bunyan's Pilgrim's Progress "Art Journal"	22
Do. Cassell	36
Bunyan's Pilgrim's Progress Religious Tract Society, set of	17
Do. Routledge	111
Do. Service of Song	33
Do. Christiana	32
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Burmah	36
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Buy your Own Cherries ... ...7 &	10

C

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Cat, Nine Lives of a	12
Central Africa	50
Children in the Wood	8
Channel Islands	60
Children's Entertainment, 1 ...	48
„ „ 2 ..	48
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Chimes, The	24
China and the Chinese	60
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" " " 2	39

D

Dame Perkins and her Grey Mare	8
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F

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Fly, Adventures with a	12
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Friendless Bob	18

G

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" a Scuttle of Coals ...	10
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" Rumours of an Election	4
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Microscopical Objects 150
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N

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New Hat 9
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,, ,, Hunting Expedition at Nepaul	30
Prodigal Son, Service of Song ...	38
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Pussy's Road to Ruin	12

Q

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R

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Return from the Tavern, The ...	4
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T

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The Life Boat	7
The Quaker and the Robber ...	4
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,, ,, H.R.H. The Prince of Wales's Animals	18

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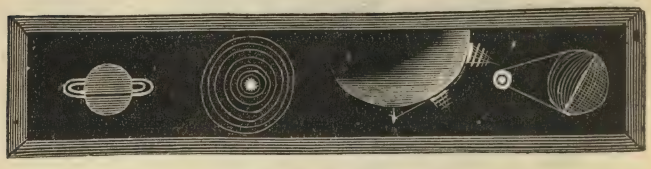
3. Great Locust—Chinese Lantern-fly and Walking Leaf—Mole Cricket and *Cimex Prasinus (two views).
4. Telemachus Butterfly. Caterpillar and Chrysalis—Sphinx Occolata, Caterpillar, and Chrysalis—Atlas Moth.
5. Dragon Fly and Larva—Nest of the Humble Bee—*Working and *Female Ants.
6. *Golden Fly and Ichneumon Ramidulus—*Sheep Gad Fly and *Diopsis Ichneumonea—*Human Louse, and *Lice from different Birds.
7. Termites or White Ants, male and female—A magnified view of a Termite in the Pupa state (called a Soldier); in the upper part of the slider is a picture representing a distant view of the Habitations of the White Ants; in the foreground of wichh are several Labourers and a Soldier, of the natural size —*A Flea, with the Egg, Larva, and Pupa.
8. A Cheese Mite and Garden Spider—Cancer Mantis—Scolopendra Morsitans.

*N.B.—Those marked with a * are magnified; the others are most of them under the natural size. The real size may be seen by referring to the page.*

Class VI.—Worms.

1. Serated Tape-worm, natural size, with a separate view of the Head, highly magnified—Nais Serpentina, magnified—Sea Anemone—Brown Holothuria.
2. Phosphoric Phyrosma—Eight-armed Cuttle-fish—Balloon Cuttle-fish—Medusa Pulmo.
3. Medusa's Head Star-fish—Duck Barnacle—Great Sea Pinna Iceland Scollop.
4. Paper Nautilus, with the animal seated in the shell—Pearly Nautilus, with the inhabitant—Tortoise-shell Limpet, and Veined Volute.
5. Snow-flaked Volute and Waved Turbo—Corded Murex—Anguine Serpula and Serpula Vermicularis, with the animal.
6. Green Polypes, natural size and magnified—Sea-bristle Coralline, magnified to shew its polype heads—Tubularia Reptans, magnified - Phosphoric Sea-Pen.
7. Red Coral, with a small branch slightly magnified, to shew its polype heads—Thick-armed Gorgonia—Cinnamon Madrepore—Madreporas, Patella, and Meandrites.
8. Vorticella Racemosa, and a group of Wheel Animals—A group of Bell Animals, and a group of the Vorticella Occolarus and the Sun Animal—Groups of the Cercaria Mutabilis, Globe Animals, and Paste Eels.

N.B.—The Animals in this Slider are Microscopic Animalcules.



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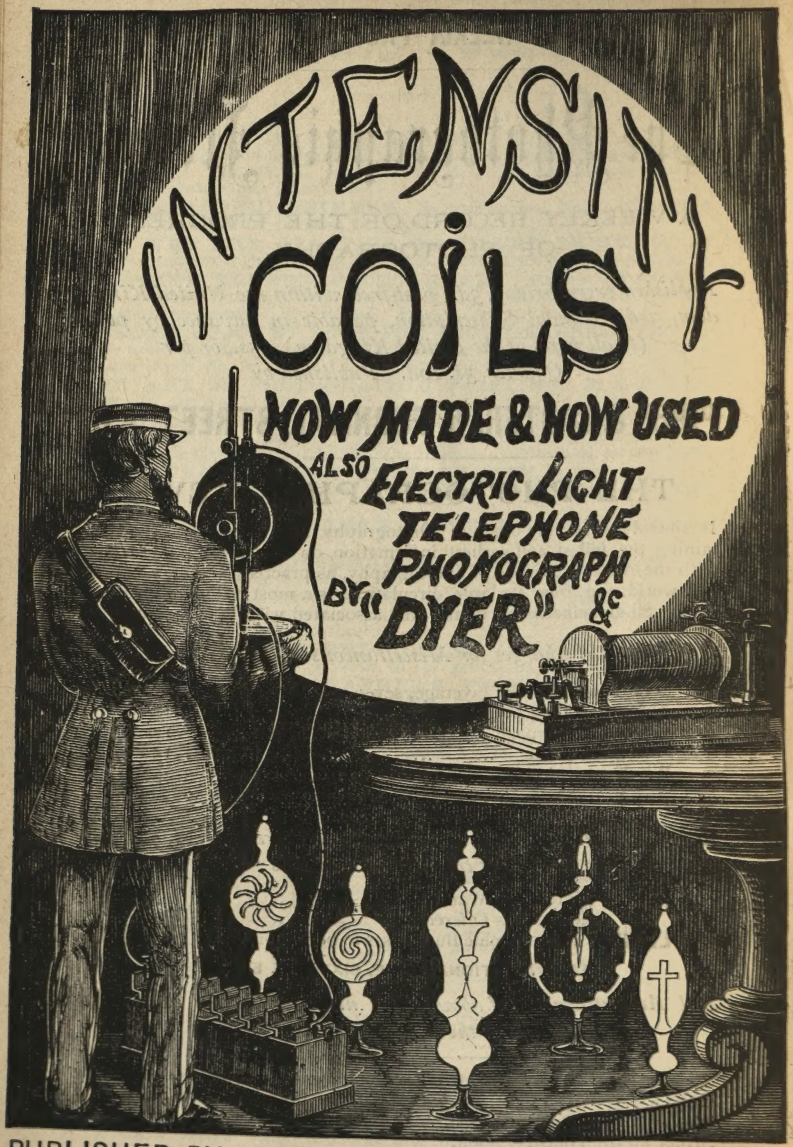

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